Title

ADVANCED DATA COLLECTION SYSTEM INSTRUMENT INTERFACE CONTROL DOCUMENT

A-DCS ICD

	Name and Function	Date	Signature
Prepared by :	METOP Team		MATRA CMT - METOP - Reçu : 20 FEV. 2001 n°: 24156
Verified by :	JL. DUQUESNE *Instrument Interface Principal Engineer* B. TEDALDI *Process Manager APM*	16/02/01 19.02.01	
Approved by :	D. HERBIN *Product Assurance APM* Ch. BOUSQUET *System Engineering APM*	19/02/01 19/02/01	
Authorized by :	JP. GARDELLE *ASTRIUM SAS METOP Project Manager*	19/02/01	

	SSST (ESA / EUM)	*Instrument Provider*	*Instrument Supplier*	*Instrument Manufacturer*
Application authorized by :	P. G. EDWARDS *METOP Project Manager (ESA)* Date :	M. COHEN *EPS Programme Manager (EUMETSAT)* Date :	C. GAL *A-DCS Project Manager (CNES)* Date :	O. FORGEOT *Project Manager (THALES Systèmes Aéroportés SA)* Date :

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DOCUMENT CHANGE LOG

Issue/ Revision	Date	Modification Nb	Modified pages	Observations
Draft	Nov. 1995	-	-	New document - PR Issue
Draft 2	July 1996	-	All	Complete revision
Issue 1	Nov. 15th, 1996	-	All	Complete revision
Iss. 1 Rev. A	Jan. 1997	MO-FX-MMT-0078.97	6	-
C/D Proposal	August 1997	MO-NT-MMT-DC-0001	75	-
Issue 2	June 12th 1998	-	All	Complete revision
Issue 3	Nov. 30th 1998	MO-MN-MMT-DC-0007 DSO/RC/AD/LM/98-248	All	Complete revision
Iss. 3 Rev. A	May, 5th 1999	DCR 39, 117, 137, 138	All	Complete revision - PDR Issue
Issue 4 Rev. 0	April 2000	See pages iv and v	All	Complete revision
Iss. 4 Rev. A	January 2001	See pages vi	All	Complete revision

DOCUMENT CHANGE LOG : ISSUE 4 REVISION 0 (1/2)

The ADCS ICD Issue 4 Rev. 0 includes the following MMS ICRs or CRs (= SSST DCRs or CRs) that have been already processed / agreed within METOP Industry and with SSST :

Pages	Change Request References	Subject
1.2	MO-IR-MMT-DC-0152 (MO-DCR-ESA-SY-181/1)	Applicable documents (see note)
1.2, 2.3, 2.4	MO-IR-MMT-DC-0187 (MO-DCR-ESA-SY-204)	Applicable documents (drawings)
1.2	MO-IR-MMT-DC-109 (MO-DCR-ESA-SY-145/1)	Pin allocation list applicable document
1.16	MO-IR-MMT-DC-155 (MO-DCR-ESA-SY-179/1)	Switch-off sequences
2.1, 2.5, 2.6, 3.53, 3.55	MO-CR-MMT-SY-0038 (MO-CR-SSST-0002)	ADCS harness to ALS
3.18, 5.3	MO-IP-MMT-DC-0159 (approved ICP)	Impacts of DCR 181/1
3.33, 3.34, 3.42-46	MO-IR-MMT-SR-210 (MO-DCR-ESA-SY-0112) : Update of ADCS Interface Circuits according to A-DCS / SARP-3 Interface Circuits, Ref. AS3-ICD-100-001/ED Ind. 0 Rev. 0 dated June 28th 1999.	Interface Circuit Diagrams Remark 1 : the total capacitance between INT.10.RETURN and CHASSIS GROUND is < 50 nF, as per DEX Fax Ref. SGE/SQY/PR4.99/293 dated July 23rd 1999. Remark 2 : Signal Ground on instrument side is not connected to the NIU for the Digital B Telemetry Processing (Data) Status Interface Circuit (Figure 3.5.2.1.2-5).
3.38	MO-CR-MMT-CF-0093 (MO-CR-SSST-0008)	Failure Propagation
3.54, 5.2, 5.14	MO-CR-MMT-CF-0092/1 (MO-CR-SSST-0010)	Test connector

Note : above referenced SSST DCR necessitates further updates to the ICD as introduced in MO-IP-MMT-DC-0159 from MMS to SSST (approved ICP).

DOCUMENT CHANGE LOG : ISSUE 4 REVISION 0 (2/2)

In addition to these already agreed changes, the following modifications are included in the ADCS ICD Issue 4 Rev. 0 :

Pages	Reasons for Changes
1.2, 1.4, 1.5, 1.6, 2.9, 2.14, 3.1, 3.3, 3.28, 3.32, 3.63	Editorial
1.7, 1.11, 2.1, 2.9, 3.34, 3.43, 5.1, 5.2, 5.3, 5.5, 5.6, 5.7, 5.16	Red-lined as per MO-MN-MMT-CF-DC-0018 March 17th 2000.
1.9	Sat. configuration update
1.10	PLM lay-out update
1.12	§ 1.3.4.2 (to be in accordance with System Requirements)
2.6	Bolt length and torque
2.7	Bonding Schematics (now consistent with the modifications requested in MO-DCR-ESA-SY-0137 already included in Issue 3 Rev. A)
3.6, 3.34	Non allocated TLMs (following agreement on MO-DCR-ESA-SY-0137 already included in Issue 3 Rev. A)
3.10, 3.11, 3.12, 3.33, 3.34, 3.59, 3.63, 4.8	Removal of TBC
3.10, 3.12	TLM list order (following agreement on MO-DCR-ESA-SY-0137 already included in Issue 3 Rev. A)
3.31, 3.48-3.52	Updates of METOP PLM harness definition (for information in the ICD).
3.60	Update of ADCS Grounding and Isolation Concept (Figure 3.8.2-1 of the ICD) : Implementation of diodes between the 10V Ground and the Signal Ground.
3.63, 3.65	Deletion of TX back-up frequency
5.3	5.2.1.2.2. Protocol Interfaces : Section deleted and reference is made to AD9.
5.4, 5.11	Updates of METOP EGSE Set-Up.

DOCUMENT CHANGE LOG : ISSUE 4 REVISION A (1/1)

The ADCS ICD Issue 4 Rev. A includes the following ASTRIUM SAS ICRs or CRs (= SSST DCRs or CRs) that have been already processed / agreed within METOP Industry and with SSST :

Pages	Change Request References	Subject
1.2	MO-DCR-ESA-DS-0314 / MO-IR-MMT-DC-319	AD5, AD6
1.2	MO-DCR-ESA-DS-0288 / MO-IR-MMT-DC-288 (MO-DCR-ESA-SY-0181/2 / MO-IR-MMT-DC-219)	AD9
2.3, 2.4	MO-DCR-ESA-DS-0314 / MO-IR-MMT-DC-319	AD5, AD6 (Drawings)
2.6	MO-IP-MMT-DC-0237 / MO-CN-DOR-PM-0168	Bolt Length
2.15	MO-DCR-ESA-SY-0280 / MO-IR-MMT-DC-0294	Thermal Heat Capacity
3.59	MO-DCR-ESA-SY-0261 / MO-IR-MMT-DC-0292	Maximum Voltage
3.59, 3.60	MO-DCR-ESA-SY-0252 / MO-IR-MMT-DC-0213	TXU Grounding
3.63	MO-DCR-ESA-DS-0312 / MO-IR-MMT-DC-0321	Receiver Max Input Level
5.12	MO-DCR-ESA-SY-0261 / MO-IR-MMT-DC-0292	Maximum Voltage

PAGE ISSUE RECORD

Issue of this document comprises the following pages at the issue shown

Pages	Issue / Revision	Pages	Issue / Revision	Pages	Issue / Revision	Pages	Issue / Revision
i to xx	Iss. 4 Rev. A						
1.1 to 1.18	Iss. 4 Rev. A						
2.1 to 2.16	Iss. 4 Rev. A						
3.1 to 3.66	Iss. 4 Rev. A						
4.1 to 4.12	Iss. 4 Rev. A						
5.1 to 5.18	Iss. 4 Rev. A						
6.1 to 6.2	Iss. 4 Rev. A						

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TBC / TBD LISTS

This document includes several TBD (to be defined) and TBC (to be confirmed) on the following pages.

$TBD_{A\text{-}DCS}$ on Pages	$TBC_{A\text{-}DCS}$ on Pages
1.17	1.14
2.5 2.6 2.9	2.1 2.5 2.6 2.13
3.4 3.5 3.6 3.7 3.8 3.9 3.10 3.12 3.13 3.15 3.20 3.22 3.62 3.63 3.65	3.65
4.4	4.1
5.1 5.7 5.8 5.9 5.13 5.15 5.16	5.16
-	-

TBD_{MET} on Pages	TBC_{MET} on Pages
-	1.11
2.2 2.5 2.7 2.12 2.14	-
3.51	3.62 3.66
-	4.2 4.3
5.10	-
-	-

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This document has been elaborated by ASTRIUM SAS along with ASTRIUM GmbH.

1. GENERAL INFORMATION

1.1. GENERAL

1.1.1. Purpose of the Document

This A-DCS Instrument Interface Control Document defines all interfaces between the A-DCS instrument and the METOP satellite series.

The ICD document forms the sole document for the definition of interfaces and formulates the binding requirements between ESA and the Instrument Supplier. It is configuration controlled by the METOP project team and formally signed off by ESA, the Instrument Supplier and the METOP prime contractor.

The ICD :

- Defines the technical resources allocated to the instrument.
- Defines the detailed mechanical, thermal and electrical interfaces.
- Defines the design verification programme which shall be implemented to demonstrate compliance with the METOP / A-DCS interface requirements.
- Defines the detailed mechanical, electrical and protocol interfaces between the instrument ground support equipment and the METOP PLM ground support equipment.
- Defines the operational interface applicable during ground, launch and flight phases.

The objective of the ICD is to ensure that :

- The instrument is designed, built and verified within the constraints imposed by the overall payload complement, satellite and launch vehicle,
- The satellite Prime Contractor is able to design, build and verify the satellite in such a manner that all instruments can be successfully integrated into the system,
- The spacecraft system can be successfully launched and operated to achieve the mission objectives of the METOP programme.

1.1.2. Documentation

In cases of conflict between the following applicable documents and the latest issue of the ICD, the A-DCS ICD shall govern.

1.1.2.1. Applicable Documentation

AD1. Product Assurance Requirements for European Third-Party Instruments
Ref. MO-RS-ESA-PA-0080

AD2. *Void*

AD3. *Void*

AD4. Electromagnetic Interference Characteristics, Measurement of, MIL-STD-462.

AD5. ADCS RPU Interface Control Drawing, Ref. 1512-200E001, Ed. 5, dated June 13th 2000.

AD6. ADCS TXU Interface Control Drawing, Ref. 1512-300E001, Ed. 3, dated June 13th 2000.

AD7. STE-PS Platform Simulator Operation and Maintenance Manual, Ref. ADII-372-MU-03-CN

AD8. A-DCS and SARP-3 Instruments - METOP Spacecraft : Interface Connectors, Ref. AS3-SI-211-144-CNES, Ed. 3, Rev. 0, October 11th 1999.

AD9. A-DCS Integration, Software and Test Requirements, Ref. AS3-SP-0I1-425-CNES, Ed. 2 Rev. 0, dated August 8th 2000.

AD10. ADCS Mission Telemetry Definition (Digital A Telemetry), Ref. AS3-SI-211-383-CNES Ed. 2 Rev. 0, October 19th 1999.

1.1.2.2. Reference Documentation

RD1. ATN-K,L,M General Instrument Interface Specification, Ref. IS-3267415

RD2. Single Space Segment, Search & Rescue, DCS System Specification Ref. MO-RS-ESA-IN-0087.

1.1.3. Acronym List

AD	Applicable Document
A-DCS	Advanced Data Collection System
AGC	Automatic Gain Control
AIT	Assembly, Integration & Test
AIV	Assembly, Integration & Verification
AMSU-A1	Advanced Microwave Sounding Unit 1
AMSU-A2	Advanced Microwave Sounding Unit 2
ARGOS	Meteorological Data Collection and Location System
ASCAT	Advanced Wind Scatterometer
AVHRR/3	Advanced Very High Resolution Radiometer
BOL	Beginning of Life
C&C	Command & Control
CAM	Coarse Acquisition Mode
CCU	Central Computer Unit (SVM)
CFI	Customer Furnished Instrument
CFRP	Carbon Fibre Reinforced Plastic
CRA	Combined Receive Antenna (A-DCS, SARR, SARP-3)
DAC	Digital Analog Converter
DBU	Digital Bus Unit
DC	Direct Current
DMMC	Downlink Message Management Centre
DRU	Data Recovery Unit
DSPG	Distributed Single Point Grounding
DTA	DCS Transmit Antenna

EGSE	Electrical Ground Support Equipment
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EOL	End of Life
FAM	Fine Acquisition Mode
FEM	Finite Element Model
FMECA	Failure Modes, Effects and Criticality Analysis
FMU	Formatting and Multiplexing Unit
FOV	Field of View
FPM	Fine Pointing Mode
Gbit	Gigabits
GNSS	Global Navigation Satellite System
GOME-2	Global Ozone Monitoring Experiment
GRAS	GNSS Receiver for Atmospheric Sounding
GSE	Ground Support Equipment
H/W	Hardware
HDLC	High-level Data Link Control
HIRS/4	High Resolution Infra-Red Radiation Sounder
HK	House Keeping
HRPT	High Resolution Picture Transmission
I/F	Interface
IASI	Infra-red Atmospheric Sounding Interferometer
ICD	Interface Control Document
ICU	Instrument Control Unit
IST	Integration System Test
kbps	kilobits per second
KLM	NOAA K, L, M series of satellites
LEOP	Launch and Early Orbit Phase
LISN	Line Impedance Stabilization Network
LRPT	Low Resolution Picture Transmission
Mbps	Megabits per Second
MCMD	Macro Command
MGSE	Mechanical Ground Support Equipment
MHS	Microwave Humidity Sounder
MIL	Military (standard)
N/A	Not Applicable
NIU	NOAA Instrument Interface Unit
OBDH	Onboard Data Handling System
OCM	Orbit Control Mode
OCOE	Over Check-Out Equipment
OCXO	Oven Controlled Crystal Oscillator
OMI	Ozone Monitoring Instrument
P/F	Platform
P/L	Payload
PA	Product Assurance
PCU	Power Conversion Unit

PLM	Payload Module
PMC	Payload Module Computer
RD	Reference Document
RF	Radio Frequency
RFC	Radio Frequency Compatibility
RFF	RF Filter
rms	root mean square
rpm	round revolutions per minute
RPU	Receiver and Processing Unit
RRM	Rate Reduction Mode
RTE	Receiver Test Equipment
Rx	Receive ; Receiver
S&R	Search and Rescue
S/C	Spacecraft
S/L	Satellite
S/S	Subsystem
S/W	Software
SARP-3	Search and Rescue Processor
SARR	Search and Rescue Repeater
SEM-2	Space Environmental Monitor
SLA	S&R L-band Tx Antenna
STE	Simulator Test Equipment (Platform Simulator)
SVM	Service Module
TB/TV	Thermal Balance / Thermal Vacuum
TBC	To be confirmed
TBD	To be defined
TC	Telecommand
TCU	Thermal Control Unit
TM	Telemetry
TT&C	Tracking, Telemetry, and Telecommand (LEOP, Emergency, and Stand-by)
Tx	Transmit, Transmitter
TXU	Transmitter Unit
YSM	Yaw Steering Mode

1.2. INSTRUMENT PRESENTATION

1.2.1. General

(For information only)

Instrument Name	A-DCS Advanced Data Collection System
Classification	Environmental monitoring system

The Advanced Data Collection System A-DCS, known also as ARGOS, collects data from platform transmitters (PTTs) located on continents and oceans in UHF frequency.

Marine PTTs located on buoys transmit oceanographic data, ship PTTs weather and oceanographic data. Land based PTTs provide meteorological and hydrological data and those on balloons atmospheric data.

A-DCS uses Doppler information to enable the location of PTTs. The data are stored on board the satellite for later transmission to ground. A-DCS also includes a transmitter function to send stored messages to the Data Collection Platforms, which have been uplinked via the receiver.

1.2.2. Scientific Objectives

(For information only)

Over 5000 environmental platforms are located around the Earth to measure environmental factors such as temperature, pressure and currents. Some of these platforms are immersed in a moving fluid, such as the ocean and the atmosphere. These moving platforms, buoys and balloons provide environmental information on velocity and direction of the ocean and wind currents.

1.2.3. Functional Description

The A-DCS block diagram is illustrated in Figure 1.2.3/1. The A-DCS is physically implemented into two units.

The environmental platforms transmit data to the A-DCS at a carrier frequency around 401.650 MHz, digital modulation format at 400 bps and 4800 bps. The A-DCS demodulates this signal and determines the carrier frequency and relative time of each transmission. This data is processed, formatted, and transferred directly to the ground and to the satellite for real-time or later transmission to ground.

1.2.3.1. Receiver Processing Unit

The receiver linearly converts the incoming signal to an intermediate frequency, that is applied to the input of the search unit and to the equivalent of Data Recovery Units (DRUs). The search unit is basically a spectrum analyzer which uses a Fast Fourier Transform to cover the 110 kHz operating frequency range.

The receiver characteristics are the following :

Centre Frequency	401.65
Antenna Polarization	RHCP

1.2.3.2. Control Unit

The control unit sequentially scans the search unit channels. It makes a binary estimate of both the signal level and frequency. These two digital words are stored in the Control Unit and are used for the assignment of a DRU to a particular receiver output signal.

1.2.3.3. Data Recovery Unit

A processing software performs the following signal functions : acquisition of the carrier, signal demodulation, bit synchronization, frame synchronization, Doppler counting, decommutation ; and a management software performs the formatting of the data.

1.2.3.4. Telemetry Encoder and Memory

The telemetry formatter interrogates the buffer in the equivalent DRUs. When the buffer is full, the encoder sends a command to shift the bits into memory. When the data transfer signal from the satellite is received by the encoder, it transfers the data out of the memory to the satellite.

1.2.3.5. Transmitter

The A-DCS instrument will be able to send messages to the users mobile terminals through its UHF transmitter (465.9875 MHz bi-phase PM 200 or 400 bps).

The user requests will be received at the Toulouse facilities of CLS, the CNES subsidiary in charge of the operations of the ARGOS system. These requests will indicate the identification of the destination terminal, the message to be transmitted at 400 bps (or 200 bps) and the time constraints (if any).

Taking into account the above and the status of the ARGOS system, the Downlink Message Management Centre (DMMC) will prepare the uploading of the request to the instrument through one of the Master Beacon of the ARGOS system.

The best situated Master Beacon is selected by the DMMC and the message to be uplinked is sent to this Master Beacon through terrestrial public network. This uplink message contains the information necessary to prepare the downlink message to be sent to the user terminal.

The uplink message is an ARGOS message the content of which is analysed upon reception by the instrument which in turn prepares the downlink message to be included in the downlink HDLC bit stream transmitted by the UHF transmitter.

In summary the function described is independent of the satellite operations and has no impact on them, e.g. the downlink is permanent and when there is no downlink message, the downlink transmits 7E7E7E7E...

Switching on / off of the A-DCS transmitting function is made through the METOP command and control centre (ground segment).

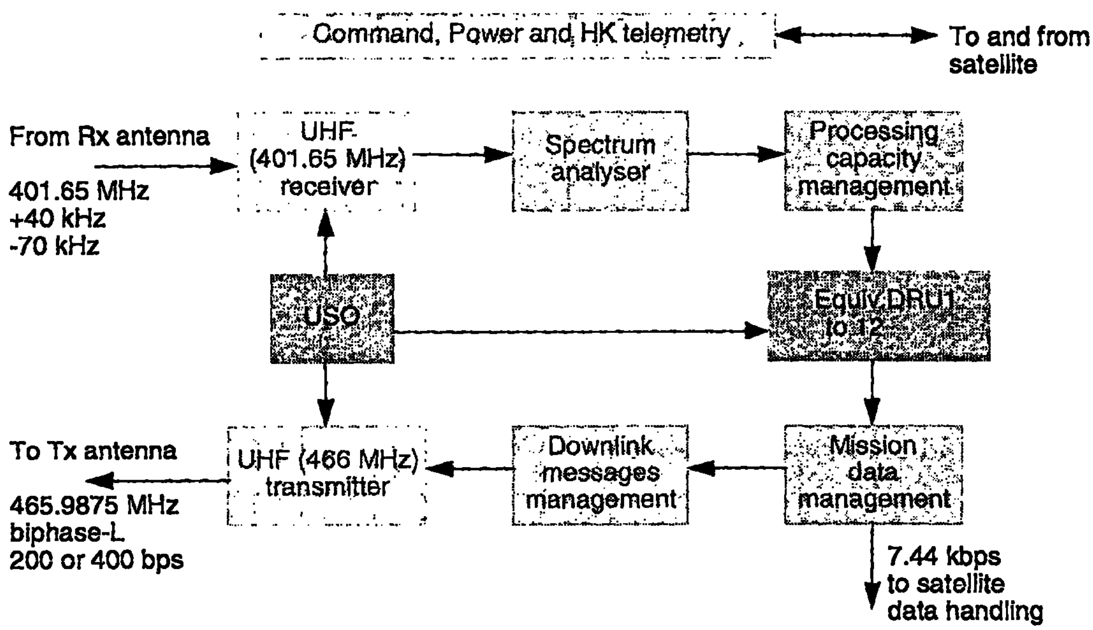


Figure 1.2.3/1 : A-DCS Functional Block Diagram

1.3. METOP SYSTEM OVERVIEW

1.3.1. Spacecraft Architecture Concept

(For information only)

The METOP spacecraft is a geocentric, three-axis stabilized satellite placed in an Earth Sun-synchronous orbit.

The satellite consists of the Service Module (SVM) and the Payload Module (PLM).

The SVM provides :

- Interface with the launcher
- On-board data acquisition
- Power generation, storage, distribution
- Housekeeping : SVM thermal control, pyro and thermal knife command generation.

The PLM provides :

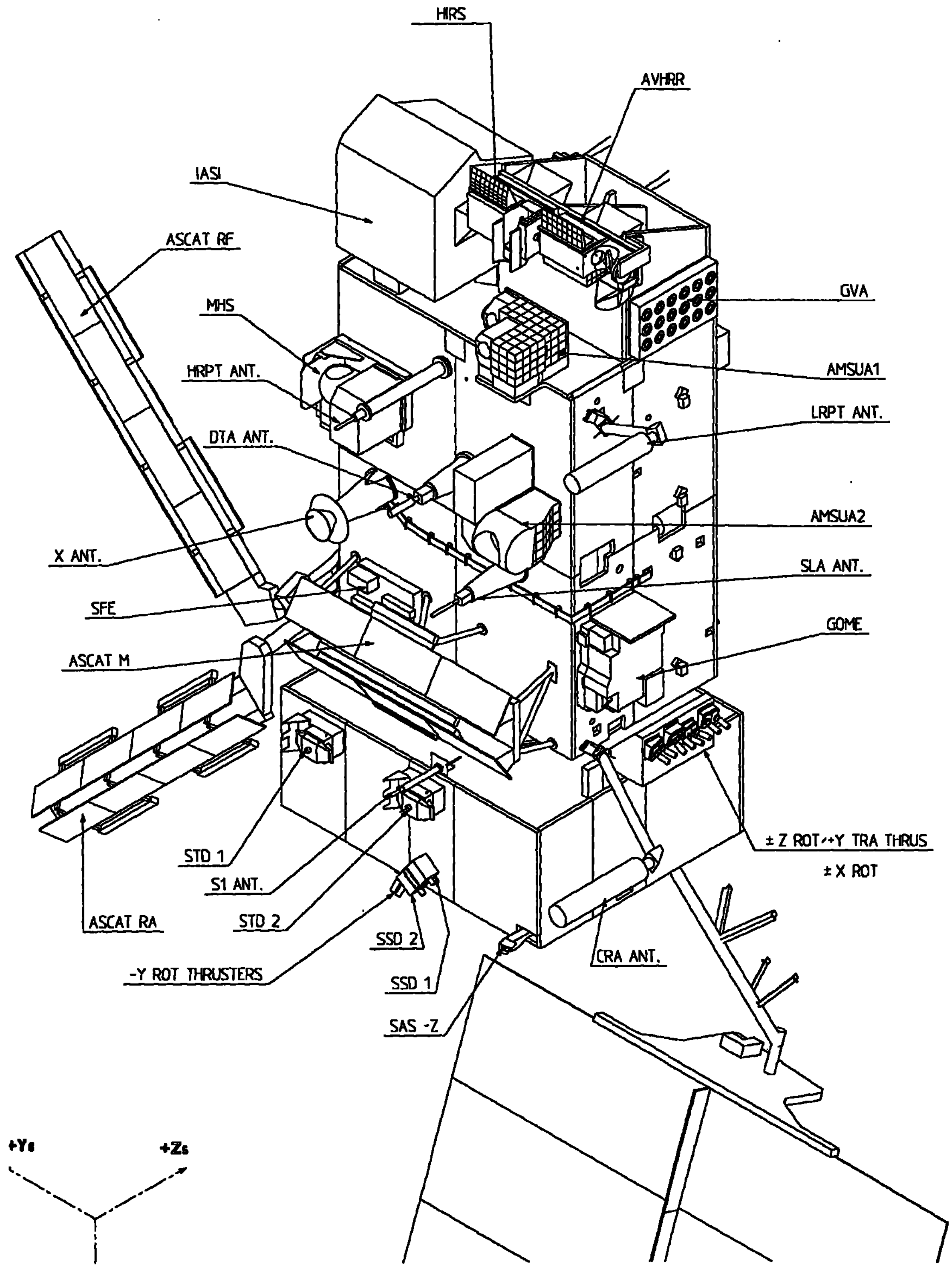
- Instrument accommodation estate
- Instrument command and control interface
- Measurement data acquisition and storage
- Measurement data formatting and downlink
- PLM thermal control
- Instrument housekeeping and thermal control
- Power conversion and distribution

The METOP satellite in-orbit configuration is illustrated in Figures 1.3.1/1. The internal PLM lay-out is illustrated in Figure 1.3.1/2.

The A-DCS interfaces with the following PLM units :

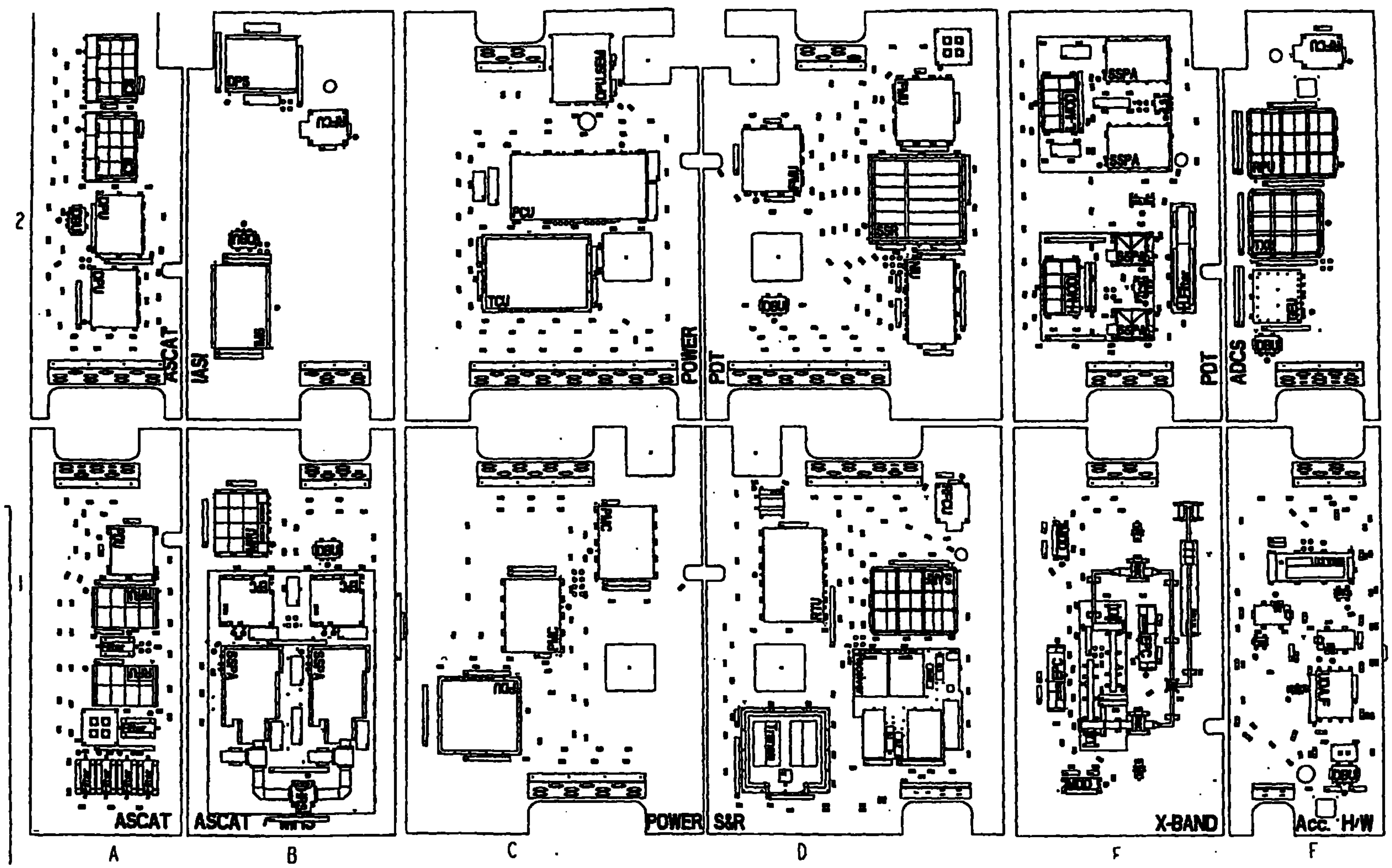
- the NOAA Instrument Interface Unit (NIU) provides all command and control interfaces to the A-DCS, i.e. configuration and mode switching (commands), command verification, housekeeping telemetry acquisition, and clock and time management. The NIU also acquires the measurement data from the instrument.
- the Power Conversion Unit (PCU) provides the A-DCS with the regulated buses.

In addition, the Thermal Control Unit (TCU) provides heater power supply for the thermal control of the units.



WARNING : MAY BE SUBJECT TO CHANGE

Figure 1.3.1/1 : METOP Satellite Overall Configuration (For Information Only)



WARNING : MAY BE SUBJECT TO CHANGE

Figure 1.3.1/2 : Internal Lay-Out (For Information Only)

1.3.2. Instrument Reference Frame

The following is a requirement for the definition of the instrument reference frame. The frame specific to the A-DCS is defined in § 2.1.3.

The instrument shall have a right handed orthogonal co-ordinate reference system F_{ADCS} (U_{ADCS} , V_{ADCS} , W_{ADCS}) and it shall be defined such that :

- the origin shall be physically located on an accessible, identifiable instrument exterior feature (e.g. the centre of one mounting hole, at the unit baseplate level)
- the U, V instrument axes define the plane that contains the unit mounting feet.
- the W axis is normal to this datum plane.

These axes shall be referred to on all drawings and any finite element description.

1.3.3. Orbital Parameters

1.3.3.1. Reference Orbit

METOP will be placed into the following reference orbit :

- Type :	Sun-synchronous
- Semi-major axis :	7197.939 km
- Repeat Cycle :	5 days (14 + 1/5 orbits per day)
- Local Solar Time :	09:30 A.M. descending node

1.3.3.2. Drift Orbit

For METOP-1, the previous orbit will be reached after a 6-month (TBC_{MET}) drifting phase (dual launch), from an initial polar orbit (close to the Sun-synchronous one) with a local solar time around 10:00 A.M. descending node.

METOP-2 and METOP-3 will be directly launched into the reference orbit.

1.3.4. Satellite Mission Phases and Operations

1.3.4.1. Mission Phases

During its lifetime, the satellite is operated through the following mission phases :

- **Launch Phase**
  The proper launch phase begins at the instant of switching the power subsystem to on-board batteries before lift-off and ends at satellite/launch vehicle separation.
- **Acquisition Phase**
  This phase starts at the end of the launch phase and ends once the satellite has acquired its operational attitude and orbit with its appendages deployed. An initial acquisition sequence leading to a system secured state, is followed by a final acquisition period.
- **Commissioning Phase**
  This phase starts once the attitude and orbit have been acquired and covers the time that subsystems and instruments are checked out. It ends when the payload is operational for the nominal orbit. For METOP-1, it starts when the satellite is still drifting to achieve the nominal local solar time of 09:30.
- ***Routine* / *Operational* Phase**
  This phase starts at the end of the commissioning phase and covers the time when the instruments are operational and the times when orbit maintenance manoeuvres are performed.

1.3.4.2. Satellite Operational Modes

(For information only)

This section describes the satellite operational modes.

1.3.4.2.1. Nominal Operational Mode

The nominal operational mode for METOP SVM is the Operational Mode (OPM), that includes a Yaw Steering guiding law [1]. During this mode, the PLM is in its Operable Mode : the instruments can be nominally operated through their different modes.

1.3.4.2.2. Orbit Control Modes

Orbit control manoeuvres for altitude maintenance or inclination maintenance are performed in SVM Orbit Control Mode (OCM).

During those modes, the PLM is still operable and the instrument nominal operations are not stopped, even if the generated measurement data may be corrupted. This is not true for the initial orbit corrections, for which the PLM and the instrument status are in LEOP / Off Modes.

---

1 According to this the Yaw Steering law, the satellite Z axis (yaw) is steered according to sinusoidal function over the orbit with an amplitude of about 4 deg.

1.3.4.2.3. Acquisition Modes

The acquisition modes encompass all actions leading to a stabilized Earth attitude, including deployment of all major appendages.

The corresponding SVM modes are the Rate Reduction Mode (RRM), the Coarse Acquisition Mode (CAM), the Fine Acquisition Modes (FAM1, FAM2 and FAM3) and the Fine Pointing Mode (FPM).

During these modes, the PLM is in the Lift-Off Mode and then LEOP Mode. In general, all instruments are switched off.

1.3.4.2.4. Contingency Cases

In the event of detection of a satellite failure, several back up modes exist at PLM and / or SVM levels.

PLM Failure Cases

For failure at PLM level only, the corresponding PLM modes are the PLM Stand-By Mode, the PLM Fix Mode and the PLM Safe Mode, depending on the failure. All instruments are switched off.

The SVM is not affected.

SVM Failure Cases

For failure at SVM level, the PLM is forced to PLM Stand-By Mode, PLM Fix Mode or PLM Safe Mode, depending on the failure, and all instruments are switched off.

The SVM enters several modes that lead to a stabilized Earth pointing attitude. From an operational point of view, those modes are similar to the very first attitude acquisition that follows the separation from the launch vehicle, but with deployed appendages.

1.3.4.2.5. Safe Mode (Sun Pointing)

In addition to the previous back-up modes, an ultimate safety level is implemented on METOP. This so-called Safe Mode performs the minimal functions for satellite survival by maintaining a Sun-pointed attitude. During the Safe Mode, the PLM is in the PLM Safe Mode and all instruments are switched off.

1.4. INSTRUMENT OPERATIONAL MODES

1.4.1. Operational Constraints

To assure proper in-orbit operations of the A-DCS, certain practices are to be observed during the mission phases (see § 1.3.4.1.). These are :

a) The initial configuration on the ground and during launch for A-DCS is the Off Mode

b) The A-DCS can be operated within the constraints herein defined, at any time during the drift orbit.

c) When initiating the A-DCS Mission Mode, the RPU shall be first switched on, a 120-minute max period (TBC_{ADCS}) shall be observed to get temperature stability for the USO.

d) It is not an issue for A-DCS to have RF signals at its input port when it is off.

e) The nominal operating mode for the A-DCS is the A-DCS Mission Mode. There is no specific requirement from the PLM during this mode.

f) In case of PLM failure, the clock / signal and power (10 & 28 V) may not be available at the instrument interfaces for a maximum duration of 36 hours.

g) The measurement data acquisition of Digital A Data from A-DCS may be corrupted in case of spacecraft failure (i.e. Data Enable and Clock interrupted and Sync. pulses present). In this case, the instrument shall be reset by ground command i.e. by powering down to Off Mode and following powering up the instrument to Mission Mode.

1.4.2. Instrument Mode Overview

1.4.2.1. A-DCS Off Mode

During the A-DCS Off Mode, the A-DCS is unpowered. No service (telemetry, monitoring...) will be performed by the METOP satellite, except thermal control.

This Off Mode for A-DCS is used :
- during the METOP launch and acquisition phases.
- during the METOP contingency cases (see § 1.3.4.2.4.).
- during the METOP safe mode (see § 1.3.4.2.5.).

The Switched TLM bus is available at the instrument interfaces only during the PLM Stand-By and Operable modes. The temperatures will be monitored only during these PLM modes.

All interface power buses and signals shall be available at the interfaces of the A-DCS to exit this mode.

1.4.2.2. A-DCS Mission Mode

This mode is defined as the normal operating mode of the A-DCS, with the instrument providing nominal receiver / processor functionalities and providing measurement data to the satellite.

The transition from Off Mode to A-DCS shall be done in a step-by-step way as described in § 1.5.3. The temperature constraints (switch-on temperatures) are dealt within § 2.3.2.2.

Switch-on / switch-off of the A-DCS transmitter functions can be done independently during the A-DCS Mission Mode.

1.4.3. Cross Reference Between Instrument and PLM Modes

Phases	PLM	A-DCS	Comments
Launch and Acquisition Phases	Lift-Off Mode LEOP Mode	Off Mode	
Pre-Operational Phase	Stand-By	Off Mode	
Operational Phase	Operable	Any	
Orbit Control Manoeuvres	Operable	Any	
	Stand-By	Off Mode	
Contingency Cases	Stand-By Fix Safe	Off Mode	

1.5. INSTRUMENT LAUNCH AND IN-ORBIT OPERATIONS

1.5.1. General

Instrument operational constraints are presented in § 1.4.1.

The minimum time between two consecutive commands is specified in § 3.2.2., except as noted below.

A-DCS telecommands are described in § 3.2.2.

The acknowledgement of the commands by the instrument is not done on-board but on the ground with Digital B and Analog Housekeeping telemetry points, as described in § 3.2.3.

Instrument operations during tests are described in § 5.

1.5.2. Instrument Sequences to A-DCS Off Mode

1.5.2.1. Nominal Sequence to Off Mode

The A-DCS instrument sequence to Off Mode shall be as following :

1) Command 1 : TXi Power Supply OFF (i = 1 or 2 depending on the transmitter which is ON).
2) Command 2 : RXj Power Supply OFF (j = 1 or 2 depending on the receiver which is ON).

1.5.2.2. Emergency Sequence to A-DCS Off Mode

In case of emergency (including depointing), the NIU shall issue the following command sequence to the instrument, which will switch down the ADCS to Off Mode :

1) ADCS TX1 Power Supply OFF
2) ADCS TX2 Power Supply OFF
3) ADCS RX1 Power Supply OFF
4) ADCS RX2 Power Supply OFF

This emergency switch-off sequence shall be completed within 50 s.

No overlap between two successive telecommand pulses is allowed (related to the requirement of the current on +10 V interface bus).

No power and no interface signal will be available at the interfaces.

Removal of all power buses is another way to trigger the A-DCS Off Mode.

Note : Handling of measurement data may be switched off immediately after emergency signal reception by the NIU.

1.5.3. Instrument Sequences to A-DCS Mission Mode

The A-DCS instrument switch-on sequence from Off Mode into Mission Mode shall be as following. The temperature constraints are presented in § 2.3.2.2.

Remark : this sequence is also applicable after an emergency sequence to Off Mode triggered by the removal of all power buses.

Instrument Initialization

1) TBD_{ADCS}

Instrument Power-Up

1) TBD_{ADCS}

1.5.4. Instrument Operations During A-DCS Mission Mode

Transmitting Function

The transmitting function is always on, unless requested by the Instrument Supplier via the operational authority. In this latter case, the operational sequence to switch the transmitting function off is TBD_{ADCS}.

2. MECHANICAL AND THERMAL INTERFACE DESCRIPTION

2.1. GENERAL

2.1.1. Interface Definition

The interface definition for the instrument is the following :

Instrument	Satellite
Mechanical	
Instrument comprising two (2) internally mounted electronic units (RPU, TXU) Bolt and washer for unit grounding boss	Attachment bolts Washers Ground strap Harness between A-DCS units
Thermal	
Thermal finishes for the units	Heaters, thermostats and thermistors for the internally mounted units.

Note : all RF devices from the transmitting and receiving antennas to the A-DCS are under the responsibility of METOP.

2.1.2. Module / Unit Identification

The Part Number and Identification Code of the A-DCS instrument are :

1) Equipment Name : ADCS RPU
ADCS TXU

2) Purchase Order Or Contract Number : N/A

3) Manufacturer Name : Thomson-CSF Detexis and CNES

4) Part No : ADCS RPU MIS : 1512-200-100
EM : 1512-200-200
FM : 1512-200-300
ADCS TXU MIS : 1512-300-100
EM : 1512-300-200
FM : 1512-300-300

5) ID Code : Replaced by Serial Number (01 to 0n, TBC_{ADCS})

6) METOP ID Code N/A

The location of the labels giving these Part Numbers and Identification Codes are defined in the Mechanical Interface Control Drawing (See § 2.1.4.).

2.1.3. Instrument Reference Frame

The reference point for all mechanical and thermal data for each of the units are shown in the Interface Control Drawings (at the interface to the PLM structure, see § 2.1.4).

The A-DCS instrument RPU and TXU Unit Interface Reference Frames, $F_{ADCS\text{-}RPU}$, $F_{ADCS\text{-}TXU}$, with the origin being at the reference point, is as defined in the Mechanical Interface Control Drawings (See § 2.1.4.1.).

2.1.4. Interface Drawings

2.1.4.1. Mechanical Interface Drawings

The A-DCS instrument RPU and TXU unit configurations and mechanical interfaces are illustrated in the following interface drawings :

- A-DCS RPU Interface Control Drawing : AD5.
- A-DCS TXU Interface Control Drawing : AD6.

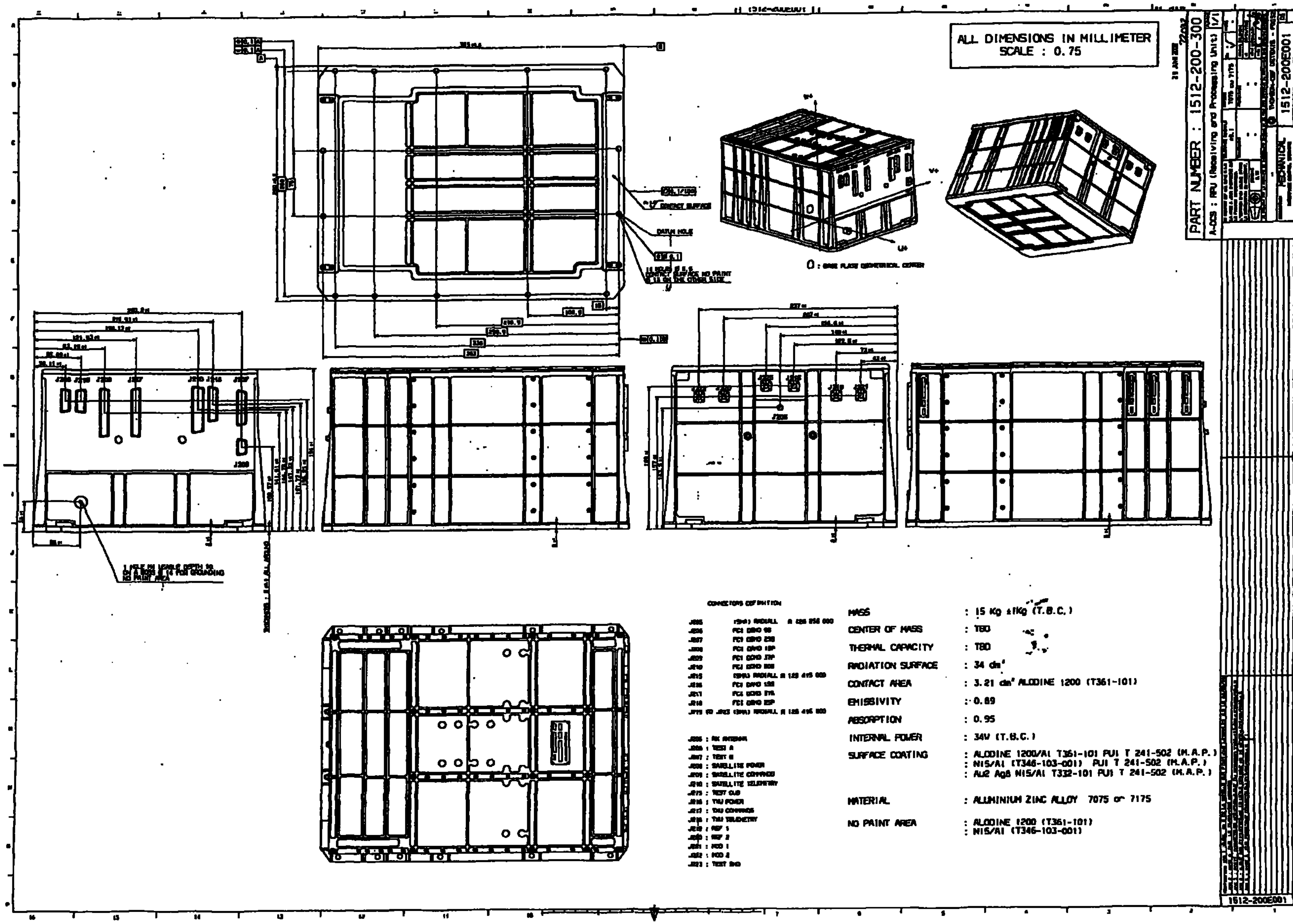
These drawings are illustrated in the following pages.

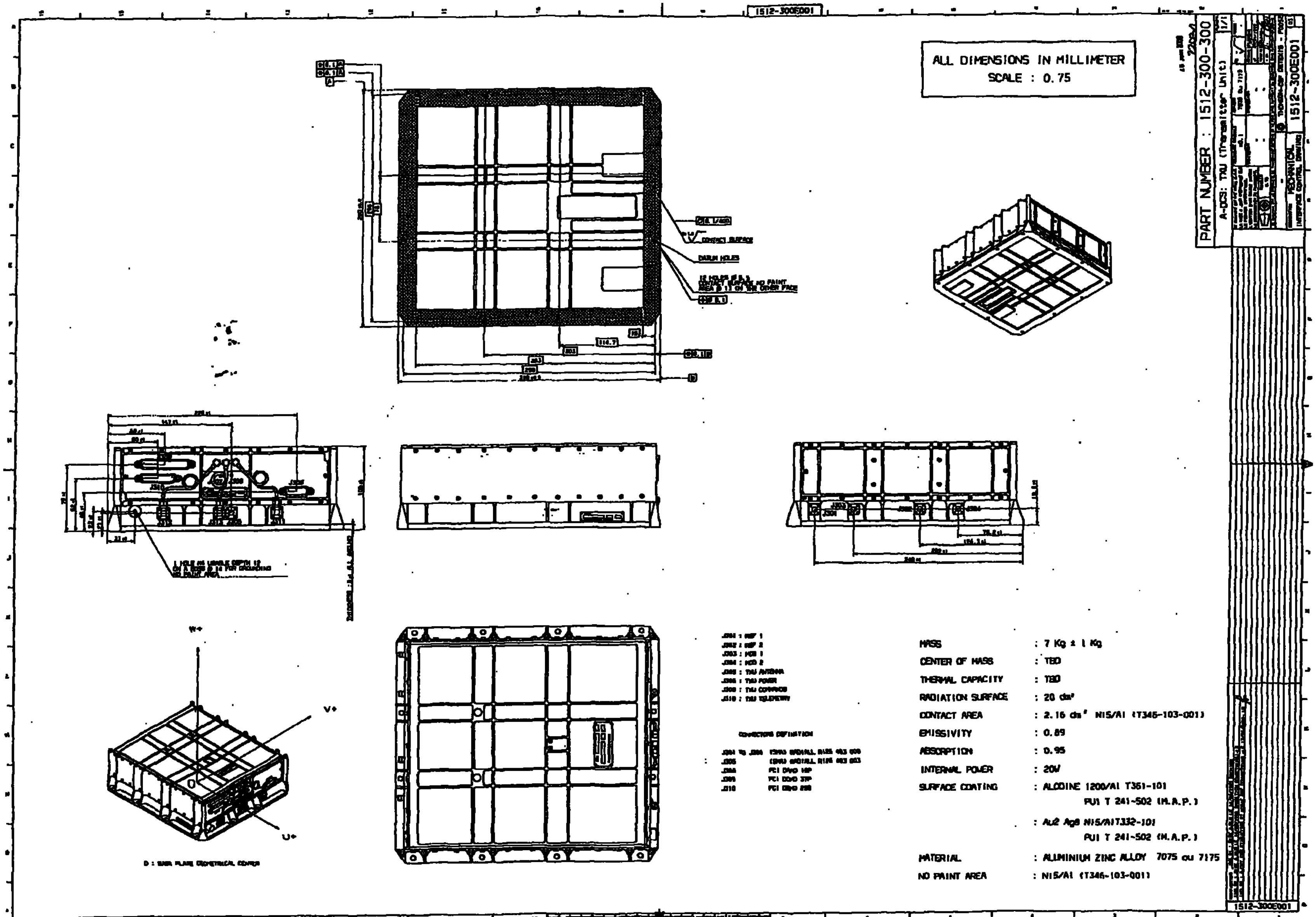
2.1.4.2. Thermal Interface Drawing

The A-DCS instrument RPU and TXU unit thermal interfaces are illustrated in TBD_{MET}.

2.1.4.3. Field of View Interface Drawing

Not applicable for A-DCS.


ALL DIMENSIONS IN MILLIMETER
SCALE : 0.75
PART NUMBER : 1512-200-300
A-DCS : RPU (Receiving and Processing Unit)
1512-200E001
MASS : 15 Kg ±1Kg (T.B.C.)
CENTER OF MASS : TBD
THERMAL CAPACITY : TBD
RADIATION SURFACE : 34 dm²
CONTACT AREA : 3.21 dm² ALODINE 1200 (T361-101)
EMISSIVITY : 0.89
ABSORPTION : 0.95
INTERNAL POWER : 34V (T.B.C.)
SURFACE COATING : ALODINE 1200/Al T361-101 PU1 T 241-502 (M.A.P.)
: NI5/Al (T346-103-001) PU1 T 241-502 (M.A.P.)
: Au2 Ag8 NI5/Al T332-101 PU1 T 241-502 (M.A.P.)
MATERIAL : ALUMINIUM ZINC ALLOY 7075 or 7175
NO PAINT AREA : ALODINE 1200 (T361-101)
: NI5/Al (T346-103-001)
CONNECTORS DEFINITION
DATUM HOLE
CONTACT SURFACE
O : BASE PLATE GEOMETRICAL CENTER


ALL DIMENSIONS IN MILLIMETER
SCALE : 0.75
PART NUMBER : 1512-300-300
A-DCS: TXU (Transmitter Unit)
MECHANICAL
INTERFACE CONTROL DRAWING
1512-300E001
W+
V+
U+
MASS : 7 Kg ± 1 Kg
CENTER OF MASS : TBD
THERMAL CAPACITY : TBD
RADIATION SURFACE : 20 dm²
CONTACT AREA : 2.16 dm² NI5/AI (T346-103-001)
EMISSIVITY : 0.89
ABSORPTION : 0.95
INTERNAL POWER : 20W
SURFACE COATING : ALODINE 1200/AI T351-101
PU1 T 241-502 (M.A.P.)
: Au2 Ag8 NI5/AIT332-101
PU1 T 241-502 (M.A.P.)
MATERIAL : ALUMINIUM ZINC ALLOY 7075 ou 7175
NO PAINT AREA : NI5/AI (T346-103-001)

2.2. MECHANICAL INTERFACE DESCRIPTION

2.2.1. Physical Envelope

The A-DCS comprises two separate units that are internally mounted within the METOP PLM. They can be accommodated in any direction on their (length x width) baseplate. The maximum harness length between the A-DCS units is 2 metres.

The maximum harness length allowed between A-DCS units is limited by their electrical performance requirements as defined for the harness. (see § 3.7.). Its mechanical configuration is TBD_{MET} (90 deg. bending configuration shall be possible up to TBD_{MET} places).

The external unit dimensions to a tolerance of ±1 mm are :

A-DCS	Length *(u)*	Width *(v)*	Height *(w)*
Receiver and Processing Unit (RPU)	365 mm	280 mm	195 mm
Transmitter Unit (TXU)	310 mm	280 mm	100 mm

Dimensions include mounting lug and connector envelopes.

2.2.2. Field of View Definition

This ICD covers only the accommodation of the A-DCS electronic units. Antenna and antenna patterns are covered in RD2. Therefore field of view requirements are not applicable.

2.2.3. Mass Properties

The mass properties of the A-DCS units are given in the following tables. The co-ordinate system used is the Instrument Interface Reference Frame for each unit, i.e. $F_{ADCS\text{-}RPU}$ and $F_{ADCS\text{-}TXU}$.

2.2.3.1. Mass and Centre of Mass Location

The A-DCS unit centre of mass locations have been measured without the attachment bolts and washers.

A-DCS	Specified Mass	Centre of Mass Location With Respect to the Reference Point (± 5 mm)		
		$U_{ADCS\text{-}UNIT}$	$V_{ADCS\text{-}UNIT}$	$W_{ADCS\text{-}UNIT}$
RPU	16.0 kg	- 161.5 TBC_{ADCS}	- 133.3 TBC_{ADCS}	+ 88.7 TBC_{ADCS}
TXU	8.0 kg	TBD_{ADCS}	TBD_{ADCS}	TBD_{ADCS}
Inter-Unit Harness	N/A	Inter-unit harness is provided by METOP.		
TOTAL	24.0 kg (without harness)			

A-DCS Mass Properties

The A-DCS units shall not exceed the above specified mass for the METOP mission.

The A-DCS mass shall be measured at ± 0.1 %.

The A-DCS (best estimate) mass is (for information only):

RPU	15.0 kg
TXU	7.0 kg
Total	22.0 kg

2.2.3.2. Moments of Inertia

The A-DCS moments of inertia about the centre of mass of the A-DCS units are as follows.

A-DCS /Unit	Moments of Inertia ($kg.m^2$) ±5%					
	I_{uu}	I_{vv}	I_{ww}	I_{uv}	I_{uw}	I_{vw}
RPU	0.132 TBC_{ADCS}	0.180 TBC_{ADCS}	0.223 TBC_{ADCS}	TBD_{ADCS}	TBD_{ADCS}	TBD_{ADCS}
TXU	TBD_{ADCS}	TBD_{ADCS}	TBD_{ADCS}	TBD_{ADCS}	TBD_{ADCS}	TBD_{ADCS}

A-DCS Moments of Inertia

Note : The moments of inertia are defined as follows :

$$\begin{bmatrix} I_{xx} & -I_{xy} & -I_{xz} \\ -I_{xy} & I_{yy} & -I_{yz} \\ -I_{xz} & -I_{yz} & I_{zz} \end{bmatrix} \quad \text{with :} \quad \begin{array}{l} I_{xx} = \int (y^2+z^2)dm \\ I_{yy} = \int (x^2+z^2)dm \\ I_{zz} = \int (x^2+y^2)dm \end{array} \quad \text{and} \quad \begin{array}{l} I_{xy} = \int xydm \\ I_{xz} = \int xzdm \\ I_{yz} = \int yzdm \end{array}$$

2.2.4. Instrument Mounting Attachments

2.2.4.1. Mounting Description

The A-DCS units are conductively coupled to the inside surface of the PLM.

The following table describes the instrument mounting hardware :

Module / Unit A-DCS	Bolt Size	Instr. Mounting Hole Diameter (mm)	Length (mm)	Torque (Nm)	Quantity
RPU	M5	5.5	17	5.5 ± 0.2 Nm	14
TXU	M5	5.5	15	5.5 ± 0.2 Nm	12

Tolerances are specified in the interface drawings (see § 2.1.4.).

2.2.4.2. Mounting Hole Position and Reference Point (Hole)

The definition of the mounting holes and the instrument Reference Bolt for A-DCS RPU and TXU are given in the Mechanical Interface Control Drawing (see § 2.1.4.).

2.2.4.3. Mounting Surfaces

RPU and TXU Side	Surface Coplanarity	0.13 mm
	Surface roughness of attachment face	≤ 1.6 microns R.A
	Total area of the mounting surface	Conductively coupled using thermal filler (see § 2.3.4.1).
METOP Side	Surface Flatness	Less than 0.1 mm in 100 mm
	Surface roughness of attachment face	≤ 1.6 microns R.A
	Shimming Accuracy for Flatness	N/A

2.2.4.4. Instrument Location

The mounting surface for the A-DCS RPU and TXU units is TBD_{MET} within the PLM.

2.2.4.5. Materials

RPU and TXU Side	Unit Baseplate	Aluminium (see AD5 and AD6)
	Unit Mounting Area Finish	Alodine 1200
METOP Side	PLM Structure	Aluminium skin with a honeycomb core
	Attachment Bolts and Washers	Titanium bolts with stainless steel washers

2.2.4.6. Thermo-Elastic Interface

Not applicable for A-DCS.

2.2.4.7. Grounding Provisions

The internal units are directly electrically grounded to the PLM structure through its baseplate or a dedicated grounding strap.

The principles of instrument bonding and location of the grounding point is sketched in Figure 2.2.4.7/1. One METOP-provided grounding strap will be attached to the grounding boss of each unit (see § 2.1.4.1.). The Instrument Supplier will provide the bolt and washer to be mounted on the unit.

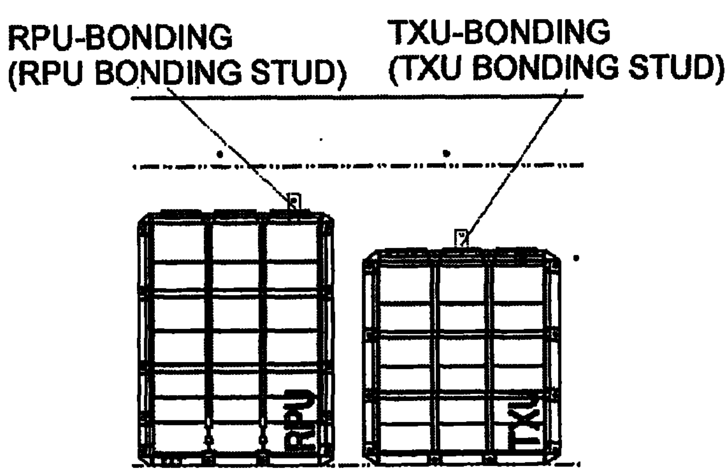


Figure 2.2.4.7/1 : Bonding of A-DCS (Generic Schematics)

2.2.5. Accessibility

Accessibility to specific parts of the instrument shall be guaranteed, when accommodated on METOP. The faces on which specific parts are accommodated are defined in the following :

A-DCS RPU and TXU *This table indicates the viewing direction from the instrument.*			
	Item	**Instrument Side**	**Access Required**
1	Locking Connector Covers	± u (RPU) ± u (TXU)	Removed only for bench tests. Reinstalled before assembly on METOP
2	Connector Dust Covers	± u (RPU) ± u (TXU)	Removed prior to connection to METOP
2	Attachment Bolts	- w	During AIT activities

The detailed position of these items are indicated on the Mechanical Interface Control Drawings (§ 2.1.4.).

2.2.6. On-Ground Alignment

Not applicable for A-DCS.

2.2.7. Deployment Mechanisms and Pyros

2.2.7.1. Deployment Mechanisms

Not applicable for A-DCS.

2.2.7.2. Pyros

Not applicable for A-DCS.

2.2.8. Interface Structural Design

For METOP, design loads (qualification loads) are specified as follows : Design Loads = 1.25 x Flight Limit Loads

For acceptance purpose, acceptance loads shall be used based on Flight Limit Loads or loads derived from coupled analysis, whichever loads are higher.

2.2.8.1. Maximum Flight Limit Loads

Flight Limits Loads are enveloping the loads, including launch, manufacturing, handling, transportation and ground testing (excluding qualification testing).

The maximum allowable flight limit loads at the instrument interface attachments to the PLM structure are the following :

> The A-DCS units shall be designed against a quasi static design load of 40 g applied for dimensioning :
> - at the unit COG
> - in any spatial direction

2.2.8.2. Safety Factors

Safety factors shall account for inaccuracies in predicted allowable and applied stresses or loads due to analysis uncertainties, manufacturing tolerances, scatter in material properties, setting interface.

Safety factor shall be applied on top of the Flight Limits Loads and are given in the following table :

Components/Load Cases	Minimum Factors of Safety		
	Proof (a)	Yield (b)	Ultimate
General Structure, Metallic			
• Verified by Analysis and Test	-	1.1	1.5
• Verified by Analysis only (c)	-	1.25	2.0
Non-Metallic Structures			
• Verified by Analysis and Test	1.2 (d)		1.5
• Verified by Analysis only (c)	-		2.0
Actuating Device Cables	2.0	-	3.0

a) Proof factor applies to Flight Limit Loads.
b) In case of structural qualification tests performed on potential flight hardware, the yield FoS shall be equivalent to the stated Ultimate FoS.
c) Use of this option requires prior approval by ESA.
d) No yielding is permitted at Proof Load.

2.2.8.3. Launch Interface Loads

The A-DCS units 1-g interface loads, calculated at each interface point (zero preload), with the instrument hard-mounted configuration are presented in the following tables (TBD_{ADCS}) :

A-DCS Unit Hard Mounted Interface Loads Based on 1 g Applied in U				
Attachment Id.		Shear Force (N)	Axial Force (N)	Moment (N.mm)
A-DCS RPU				
A-DCS TXU				

A-DCS Unit Hard Mounted Interface Loads Based on 1 g Applied in V				
Attachment Id.		Shear Force (N)	Axial Force (N)	Moment (N.mm)
A-DCS RPU				
A-DCS TXU				

A-DCS Unit Hard Mounted Interface Loads Based on 1 g Applied in W				
Attachment Id.		Shear Force (N)	Axial Force (N)	Moment (N.mm)
A-DCS RPU				
A-DCS TXU				

2.2.8.4. Structural Frequency Characteristics

The A-DCS units have a first frequency above 100 Hz (119 Hz if only analytically determined).

2.2.8.5. Structural Mathematical Models - Applicability for A-DCS

This section is not applicable to A-DCS.

2.3. THERMAL INTERFACE DESCRIPTION

2.3.1. Thermal Control Concept

The A-DCS RPU and TXU units are category B units. The instrument is responsible for the unit internal thermal design. The control of the external thermal environment for these units is under the responsibility of the METOP PLM.

2.3.1.1. Thermal Control During Nominal Operations

The nominal operations correspond to the A-DCS Mission Mode.

During these modes, the instrument unit temperature is controlled by passive design supplemented by heaters. The METOP provided heaters and temperature sensors are mounted externally to the units.

2.3.1.2. Thermal Control During Non Nominal / Contingency Operations

The non nominal / contingency mode corresponds to the A-DCS Off Mode.

During this mode, METOP provided heaters are used to maintain non-operational temperatures and are controlled using internal thermostats. Those are external to the A-DCS units.

2.3.2. Instrument Thermal Requirements

2.3.2.1. Instrument Temperature Range

2.3.2.1.1. On-Orbit Temperature Range

Instrument internal temperatures will fall within instrument design limits as long as the interface temperatures as defined in § 2.3.2.2. are maintained.

2.3.2.1.2. Ground Testing Temperature limits

The interface temperatures as defined in § 2.3.2.2. shall not be exceeded during ground tests.

The minimum operational temperature of -5 deg. C can be reduced down to -10 deg. C with reduced instrument performances.

2.3.2.1.3 Ground Storage and Transportation Temperature Range

During ground storage, with the instrument installed on the satellite, and during transportation of the complete spacecraft, the temperatures of the instrument will be maintained in the range :

-30 to + 60 deg. C.

2.3.2.2. Temperatures at the Interface

The operating, non-operating and switch-on temperatures for the A-DCS units at the instrument / satellite interface are defined hereafter :

A-DCS Temperatures at the Interface (Deg. C)					
Ref. Point	Operation		Non-Operation		Switch-On
Location	Min.	Max.	Min.	Max.	Min.
RPU	-5	+45	-30	+60	-10
TXU	-5	+45	-30	+60	-10

The Temperature Reference Point on the instrument baseplate at which these temperatures apply is defined in the drawing TBD_{MET}. It shall be at box flange between two mounting holes.

Stability Requirements

There is a thermal stability requirement for the two units in Mission Mode.

Within one orbit period, the maximum allowable temperature variation at the RPU and TXU Temperature Reference Point shall be 10 deg. C peak to peak. The long term mean temperature will fall within the defined operating temperature range.

2.3.2.3. Radiative Requirements

The surfaces of A-DCS units are black painted except the attachment interfaces.

2.3.3. Thermal Control Budgets

2.3.3.1. Heater Power Budgets

Not applicable for A-DCS.

2.3.3.2. Instrument Thermal Dissipation

The dissipation of the A-DCS instrument is constant throughout the orbit and is (see § 3.4.2) :

	A-DCS Thermal Dissipation (Watts)			
	Satellite Nominal Operating Modes			Safe Mode
	Minimum Dissipation TBC_{ADCS}		Maximum Dissipation	min / Max.
	Operating Mode BOL	Off Mode	Operating Modes EOL	Off Mode EOL
RPU	36	0	36	0
TXU	0 / 24	0	0 / 24	0
TOTAL	*36 / 60*	*0*	*36 / 60*	*0*

2.3.3.3. Heat Exchange Budgets

The A-DCS units are conductively coupled to the METOP PLM

2.3.3.3.1. Conductive Heat Transfer Budget

Not applicable for A-DCS.

2.3.3.3.2. Joint Characteristics

The A-DCS units are conductively coupled to the inside of the PLM panel using thermal filler.

2.3.3.3.3. Radiative Heat Transfer Budget

This section is not applicable to A-DCS.

2.3.4. Thermal Interfaces

The A-DCS conductive and radiative characteristics are described by a single node model as shown.

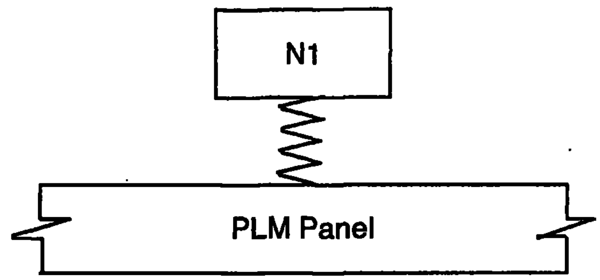


Figure 2.3.4/1 : A-DCS Simplified Interface Model

2.3.4.1. Conductive Interfaces

The thermal conductance between the A-DCS units and the Payload Module is :

A-DCS Units	Node	Thermal Conductance (W/K)	Thermal Conductivity (W/cm².K)
RPU	N1-PLM	N/A	≥ 0.038
TXU	N1-PLM	N/A	≥ 0.038

The A-DCS units are conductively coupled to the external surfaces of the PLM. The contact area is defined as the foot print area and is given as :

A-DCS Units	Contact Area (m²)
RPU	See AD5
TXU	See AD6

2.3.4.2. Radiative Interfaces

2.3.4.2.1. Radiative Characteristics

The A-DCS unit radiator areas are :

Unit	Radiator Area	
	Node	Area (m²)
RPU	N1	See AD5
TXU	N1	See AD6

A-DCS Unit Radiator Areas

The thermal radiative environment temperature in the hot case is TBD_{MET} deg. C.

2.3.4.2.2. Thermo-Optical Properties

The A-DCS unit surfaces are black painted.

The thermo-optical properties of the finishes are given in the following table :

#	Acronym	Surface / Material	Solar Absorptance			IR
			BOL *	EOL * 5yr.	EOL * 6yr.	Emit-tance
1	CHM306TTT	MAP 1	0.95	0.95	0.95	0.90

* : these values are not normally applicable but are required for the modelization (ESARAD).

A-DCS Material Thermo-Optical Properties

2.3.4.3. Thermal Heat Capacity

Unit	Node	Thermal Heat Capacity (J/K)
RPU	N1	13890
TXU	N1	5510

2.3.4.4. Instrument Temperature Measurement

This section is not applicable for A-DCS.

2.3.4.5. Heater Definition

This section is not applicable for A-DCS.

2.3.4.6. Thermal Interface Models

Required Model for A-DCS : No

2.4. INSTRUMENT AND DISTURBANCE INTERFACES

This section is not applicable to A-DCS.

3. COMMAND AND CONTROL, MEASUREMENT DATA, ELECTRICAL, EMC AND RFC INTERFACE DESCRIPTION

3.1. ELECTRICAL INTERFACE OVERVIEW

The avionics interface between the METOP Payload Module (PLM) and the A-DCS instrument is handled via the Power Conditioning Unit (PCU) and the NOAA Interface Unit (NIU). The thermal control is provided by the Thermal Control Unit.

The A-DCS receives RF data from the RF Filter (RFF - Accommodation Hardware).

The A-DCS provides RF output data to the DCS Transmit Antenna (DTA).

For adaptation of the single ended interfaces of A-DCS, a special grounding concept is described in § 3.8 (EMC).

The command and housekeeping budget for the instrument is as follows :
- 15 pulse discrete commands
- 7 level discrete commands
- 16 digital B telemetry parameters, each 1 bit
- 20 analog telemetry parameters, each to be converted to 8 bits within NIU.

Figure 3.1-1 gives an overview on the electrical interfaces between PLM, RFF, DTA and A-DCS as well the A-DCS internal interfaces between RPU and TXU.

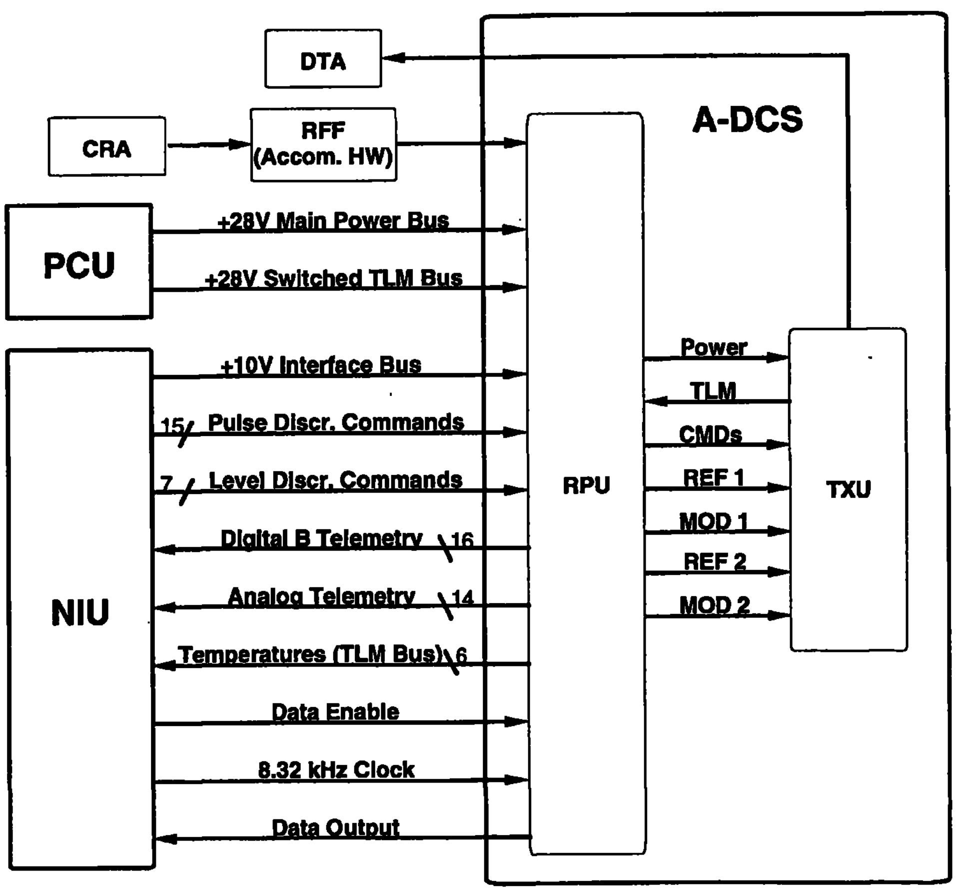


Figure 3.1-1 : A-DCS Electrical Interface Overview

3.2. COMMAND AND CONTROL FUNCTIONAL DESCRIPTION

This section describes the command and control concept for the A-DCS Instrument.

'Command and Control' comprises the activities resp. data flows for commanding of the instrument as well as for the acquisition of instrument housekeeping data.
Additionally, the instrument provides an interface of measurement data which is described in § 3.3.

These two data sets are treated separately in the METOP satellite.

Commanding of the instrument and acquisition of instrument housekeeping telemetry is performed under the control of the NOAA Interface Unit (NIU). Commands are distributed from the PMC via the PLM OBDH Bus to the NOAA Interface Unit (NIU) which translates or converts the functional and electrical interfaces to NOAA instruments and controls command execution. Vice versa housekeeping data are transferred from the instrument and transmitted to ground.

Three data sets are made available by the instrument :

- Digital A data
- Digital B data
- Analog data

Digital A data are in the above sense 'measurement data' and are handled by NIU. They are not routed via the PLM OBDH Bus to the PMC and not used for housekeeping by the satellite.

Digital B and analog data are housekeeping data. Both are reported to the ground via S-band telemetry.

3.2.1. Protocol

Not applicable for A-DCS.

3.2.2. Telecommands

Telecommands to the instrument shall be provided by the NIU.

The minimum time between two consecutive commands is 100 µs.

The instrument shall be commanded by Pulse Discrete Commands[1] and by Level Discrete Commands[2].

---

1 *Pulse Discrete Command Definition*
The pulse discrete command is normally used to change the state of a latching relay in the instrument. An ON or TRUE condition is issued in the form of a pulse to the instrument over a single line.

2 *Level Discrete Command Definition*
The level discrete command presents a ON or TRUE (resp. OFF or FALSE) condition to the instrument full time, until the same command is given to change the state to OFF or FALSE (resp. OFF or FALSE).

All commands shall be issued to the instrument one command at a time.

Any pulse ON condition may last for considerable time in case of a spacecraft anomaly. The instrument shall not be damaged by such an occurrence.

The METOP satellite will provide capabilities for pre-programming of the A-DCS of up to 36 hours. The instrument shall cope with this pre-programming period, and not require any intermediate command and control process.

The commands to operate the instrument shall be as listed in Table 3.2.2-1.

Note : The operational modes and sequences of commanding are defined in § 1.4 and 1.5.

3.2.2.1. Telecommand Definition

The satellite shall provide to the instrument all commands which are listed in Table 3.2.2-1.

Nr.	Telecommand	Mnemo	Type	Remarks
1	ADCS RX1 Select		Pulse	
2	ADCS RX2 Select		Pulse	
3	ADCS RX1 Power Supply On		Pulse	
4	ADCS RX1 Power Supply Off		Pulse	
5	ADCS RX2 Power Supply On		Pulse	
6	ADCS RX2 Power Supply Off		Pulse	
7	ADCS TX1 Select		Pulse	
8	ADCS TX2 Select		Pulse	
9	ADCS TX1 Power Supply On		Pulse	
10	ADCS TX1 Power Supply Off		Pulse	
11	ADCS TX2 Power Supply On		Pulse	
12	ADCS TX2 Power Supply Off		Pulse	
13	ADCS Software Restart		Pulse	
14	ADCS Uploading Authorization		Pulse	Uploading authorization of the on-board software
15	ADCS Strobe Level Commands		Pulse	Strobe of the Level Discrete CMDs
16	ADCS Level CMD 0		Level	
17	ADCS Level CMD 1		Level	
18	ADCS Level CMD 2		Level	
19	ADCS Level CMD 3		Level	
20	ADCS Level CMD 4		Level	
21	ADCS Level CMD 5		Level	
22	ADCS Level CMD 6		Level	

Table 3.2.2-1 : Telecommand Definition

Combinations of A-DCS Level Commands (Level Command 0 to Level Command 6) allow the definition of 128 combined commands which are decoded by the A-DCS. These used command combinations are summarized in Table 3.2.2-2. Undefined level commands are ignored by the A-DCS.

Telecommand		Command Line Configuration							Function Enabled	Notes
		LC7	LC6	LC5	LC4	LC3	LC2	LC1		
C1	ADCS Combined Level CMD 1								:	
:	:								:	
:									TBD_{ADCS}.	
:	:								:	
Cn	ADCS Combined Level CMD n								:	

n : TBD_{ADCS}

Note : the combinations "all zero" and "all one" shall not be used by ADCS.

Table 3.2.2-2 : Combined A-DCS Level Commands

3.2.2.2. Telecommand Functional Description

Details on the functions of each A-DCS command are given in this section.

1) ADCS RX1 Select

Sets RX_SELECT latching relay and RX_ANTENNA_SELECT latching relay to enable Receiver 1 (RX1) and disable Receiver 2 (RX2).

2) ADCS RX2 Select

Sets RX_SELECT latching relay and RX_ANTENNA_SELECT latching relay to enable Receiver 2 (RX2) and disable Receiver 1 (RX1).

3) ADCS RX1 Power Supply On

Applies power to RX1.

4) ADCS RX1 Power Supply Off

Removes power from RX1.

5) ADCS RX2 Power Supply On

Applies power to RX2.

6) ADCS RX2 Power Supply Off

Removes power from RX2.

7) ADCS TX1 Select

Sets TX_SELECT latching relay and TX_ANTENNA_SELECT latching relay to enable Transmitter 1 (TX1) and disable Transmitter 2 (TX2).

8) ADCS TX2 Select

Sets TX_SELECT latching relay and TX_ANTENNA_SELECT latching relay to enable Transmitter 2 (TX2) and disable Transmitter 1 (TX1).

9) ADCS TX1 Power Supply On

Applies power to TX1, if selected.

10) ADCS TX1 Power Supply Off

Removes power from TX1.

11) ADCS TX2 Power Supply On

Applies power to TX2, if selected.

12) ADCS TX2 Power Supply Off

Removes power from TX2.

13) ADCS Software Restart

Restarts signal / data processing circuits.

14) ADCS Uploading Authorization

Enables signal / data processing circuits to accept upload message.

15) ADCS Strobe Level Commands

Transfers Level Discrete Commands to signal / processing circuits.

16) ADCS Combined Level CMD 1

TBD_{ADCS}

:

:

:

15+n) ADCS Combined Level CMD n

TBD_{ADCS}

3.2.3. Housekeeping Telemetry

This section describes the A-DCS Digital B and Analog Telemetry.

3.2.3.1. General Requirements

The NIU shall only acquire the instrument-provided digital-B and analog HK data at any time when the instrument is in Mission Mode.

The NIU will read out the following housekeeping telemetry formats from the instrument :
- Analog HK
- Digital HK ("Digital B").

The NIU will sample both analog and digital B housekeeping telemetry, with periods of :
- 16 seconds nominally
- up to 1/8 s for any selected parameter on request.

Analog data shall be acquired and converted within the NIU to 8 bit digital information with a 5.12 V full scale resolution (LSB = 20 mV).

No instrument housekeeping data shall be monitored by the METOP satellite. The verification of command execution will be performed by the Ground System with Analog Housekeeping and Digital B telemetry points.

Non allocated or spare housekeeping telemetry points (analog and Digital B) shall be terminated on instrument side.

3.2.3.2. Digital B Telemetry

The instrument shall provide the Digital B telemetry as listed in Table 3.2.3-1.

The Digital B telemetry points shall be defined as following :

1.) ADCS Status RX Power Select

TBD_{ADCS}

2.) ADCS Status RX Antenna Select

TBD_{ADCS}

3.) ADCS Status RX1 On / Off

TBD_{ADCS}

4.) ADCS Status RX2 On / Off

TBD_{ADCS}

5.) ADCS Status TX Power Select

TBD_{ADCS}

6.) ADCS Status TX Antenna Select

TBD_{ADCS}

7.) ADCS Status TX1 On / Off

TBD_{ADCS}

8.) ADCS Status TX2 On / Off

TBD_{ADCS}

9.) Status ADCS Data 0

TBD_{ADCS}

10.) Status ADCS Data 1

TBD_{ADCS}

11.) Status ADCS Data 2

TBD_{ADCS}

12.) Status ADCS Data 3

TBD_{ADCS}

13.) Status ADCS Data 4

TBD_{ADCS}

14.) Status ADCS Data 5

TBD_{ADCS}

15.) Status ADCS Data 6

TBD_{ADCS}

16.) Status ADCS Data 7

TBD_{ADCS}

Nr.	Telemetry Point Name	State		Remark
		Logic "1" (Low Voltage)	Logic "0" (High Voltage)	
1	ADCS Status RX Power Select	Side 1	Side 2	
2	ADCS Status RX Antenna Select	Side 1	Side 2	
3	ADCS Status RX1 On / Off	OFF	ON	
4	ADCS Status RX2 On / Off	OFF	ON	
5	ADCS Status TX Power Select	Side 1	Side 2	
6	ADCS Status TX Antenna Select	Side 1	Side 2	
7	ADCS Status TX1 On / Off	OFF	ON	
8	ADCS Status TX2 On / Off	OFF	ON	
9	Status ADCS Data 0	TBD_{ADCS}	TBD_{ADCS}	
10	Status ADCS Data 1	TBD_{ADCS}	TBD_{ADCS}	
11	Status ADCS Data 2	TBD_{ADCS}	TBD_{ADCS}	
12	Status ADCS Data 3	TBD_{ADCS}	TBD_{ADCS}	
13	Status ADCS Data 4	TBD_{ADCS}	TBD_{ADCS}	
14	Status ADCS Data 5	TBD_{ADCS}	TBD_{ADCS}	
15	Status ADCS Data 6	TBD_{ADCS}	TBD_{ADCS}	
16	Status ADCS Data 7	TBD_{ADCS}	TBD_{ADCS}	

Note : All digital B telemetry reads Logic "1" when the A-DCS is OFF.

Table 3.2.3-1a : A-DCS Digital B Telemetry

Following are the Digital B Telemetry status as function of the different telecommands :

Nr.	Telecommand	Digital B Telemetry Status	Timing
Pulse Commands			
1	ADCS RX1 Select	TBD_{ADCS}	TBD_{ADCS}
2	ADCS RX2 Select	TBD_{ADCS}	TBD_{ADCS}
3	ADCS RX1 Power Supply On	TBD_{ADCS}	TBD_{ADCS}
4	ADCS RX1 Power Supply Off	TBD_{ADCS}	TBD_{ADCS}
5	ADCS RX2 Power Supply On	TBD_{ADCS}	TBD_{ADCS}
6	ADCS RX2 Power Supply Off	TBD_{ADCS}	TBD_{ADCS}
7	ADCS TX1 Select	TBD_{ADCS}	TBD_{ADCS}
8	ADCS TX2 Select	TBD_{ADCS}	TBD_{ADCS}
9	ADCS TX1 Power Supply On	TBD_{ADCS}	TBD_{ADCS}
10	ADCS TX1 Power Supply Off	TBD_{ADCS}	TBD_{ADCS}
11	ADCS TX2 Power Supply On	TBD_{ADCS}	TBD_{ADCS}
12	ADCS TX2 Power Supply Off	TBD_{ADCS}	TBD_{ADCS}
13	ADCS Software Restart	TBD_{ADCS}	TBD_{ADCS}
14	ADCS Uploading Authorization	TBD_{ADCS}	TBD_{ADCS}
15	ADCS Strobe Level Commands	Not applicable	-
Level Commands (Combined)			
16	ADCS Combined Level CMD 1	TBD_{ADCS}	TBD_{ADCS}
:	:	:	:
:	:	:	:
15+n	ADCS Combined Level CMD n	TBD_{ADCS}	TBD_{ADCS}

Table 3.2.3-1b : Instrument Digital B Telemetry vs. Commands

3.2.3.3. Analog Telemetry

The A-DCS provides analog telemetry channels as listed in Table 3.2.3-2 to monitor on ground the health of the instrument. It shall be considered that telemetry of analog voltage and temperature (analog telemetry) will be valid by 1 s after switching-on of instrument telemetry, i.e. TBD_{ADCS} command has been sent.

Six (6) Analog Temperature Telemetry points shall be available whenever the 28 V Analog Temperature Telemetry Bus is powered and be valid within 1 s after Analog Temperature Telemetry Bus has been commanded ON (independent of A-DCS mode). Those points are defined in Table 3.2.3-2.

Typical valid data ranges and values are shown in Table 3.2.3-2.

The telemetry points shall be defined as following :

1.) ADCS RPU Temperature

Shall monitor RPU case temperature.

2.) ADCS TXU Temperature

Shall monitor TXU case temperature.

3.) ADCS Temperature Spare 0

TBD_{ADCS}

4.) ADCS Temperature Spare 1

TBD_{ADCS}

5.) ADCS Temperature Spare 2

TBD_{ADCS}

6.) ADCS Temperature Spare 3

TBD_{ADCS}

7.) ADCS RPU Power Voltage +5 V

Shall monitor RPU internal +5 V line voltage.

8.) ADCS RPU Power Voltage -5 V

Shall monitor RPU internal -5 V line voltage.

9.) ADCS RPU Power Voltage +12 V

Shall monitor RPU internal +12 V line voltage.

10.) ADCS RPU Power Voltage –12 V

Shall monitor RPU internal -12 V line voltage.

11.) ADCS TXU Power Voltage +5 V

Shall monitor TXU internal +5 V line voltage.

12.) ADCS TXU Power Voltage -5 V

Shall monitor TXU internal -5 V line voltage.

13.) ADCS TXU Power Voltage +12 V

Shall monitor TXU internal +12 V line voltage.

14.) ADCS TXU Power Voltage –12 V

Shall monitor TXU internal -12 V line voltage.

15.) ADCS OCXO Oven Current

Shall monitor the OCXO oven current.

16.) ADCS OCXO Output Level

Shall monitor the OCXO output level.

17.) ADCS Transmitter Output Power

Shall monitor the TXU output power.

18.) ADCS TX Amplifier DC Current

Shall monitor the transmitter amplifier current.

19.) ADCS RPU Power Converter Temperature

Shall monitor RPU Power Converter temperature.

20.) ADCS TXU Power Converter Temperature

Shall monitor TXU Power Converter temperature.

The analog telemetry shall have the performance as defined in Table 3.2.3-2. The transfer function between physical range and voltage range is part of the deliverables / as-built data.

Nr.	Telemetry Point Name	Physical Range	Remarks
1	ADCS RPU Temperature	-10 to +80 deg. C	Powered by the Analog Temp. TLM Bus
2	ADCS TXU Temperature	-10 to +80 deg. C	Powered by the Analog Temp. TLM Bus
3	ADCS Temperature Spare 0	-10 to +80 deg. C	Powered by the Analog Temp. TLM Bus
4	ADCS Temperature Spare 1	-10 to +80 deg. C	Powered by the Analog Temp. TLM Bus
5	ADCS Temperature Spare 2	-10 to +80 deg. C	Powered by the Analog Temp. TLM Bus
6	ADCS Temperature Spare 3	-10 to +80 deg. C	Powered by the Analog Temp. TLM Bus
7	ADCS RPU Power Voltage +5 V	TBD_{ADCS}	
8	ADCS RPU Power Voltage -5 V	TBD_{ADCS}	
9	ADCS RPU Power Voltage +12 V	TBD_{ADCS}	
10	ADCS RPU Power Voltage -12 V	TBD_{ADCS}	
11	ADCS TXU Power Voltage +5 V	TBD_{ADCS}	
12	ADCS TXU Power Voltage -5 V	TBD_{ADCS}	
13	ADCS TXU Power Voltage +12 V	TBD_{ADCS}	
14	ADCS TXU Power Voltage -12 V	TBD_{ADCS}	
15	ADCS OCXO Oven Current	TBD_{ADCS}	
16	ADCS OCXO Output Level	TBD_{ADCS}	
17	ADCS Transmitter Output Power	TBD_{ADCS}	
18	ADCS Tx Amplifier DC Current	TBD_{ADCS}	
19	ADCS RPU Power Converter Temperature	TBD_{ADCS}	
20	ADCS TXU Power Converter Temperature	TBD_{ADCS}	

Table 3.2.3-2 : Analog Telemetry

Following are the Analog Telemetry status as function of the different telecommands :

Nr.	Telecommand	Analog Telemetry Status	Timing
Pulse Commands			
1	ADCS RX1 Select	TBD_{ADCS}	TBD_{ADCS}
2	ADCS RX2 Select	TBD_{ADCS}	TBD_{ADCS}
3	ADCS RX1 Power Supply On	TBD_{ADCS}	TBD_{ADCS}
4	ADCS RX1 Power Supply Off	TBD_{ADCS}	TBD_{ADCS}
5	ADCS RX2 Power Supply On	TBD_{ADCS}	TBD_{ADCS}
6	ADCS RX2 Power Supply Off	TBD_{ADCS}	TBD_{ADCS}
7	ADCS TX1 Select	TBD_{ADCS}	TBD_{ADCS}
8	ADCS TX2 Select	TBD_{ADCS}	TBD_{ADCS}
9	ADCS TX1 Power Supply On	TBD_{ADCS}	TBD_{ADCS}
10	ADCS TX1 Power Supply Off	TBD_{ADCS}	TBD_{ADCS}
11	ADCS TX2 Power Supply On	TBD_{ADCS}	TBD_{ADCS}
12	ADCS TX2 Power Supply Off	TBD_{ADCS}	TBD_{ADCS}
13	ADCS Software Restart	TBD_{ADCS}	TBD_{ADCS}
14	ADCS Uploading Authorization	TBD_{ADCS}	TBD_{ADCS}
15	ADCS Strobe Level Commands	TBD_{ADCS}	TBD_{ADCS}
Level Commands (Combined)			
16	ADCS Combined Level CMD 1	TBD_{ADCS}	TBD_{ADCS}
:	:	:	:
:	:	:	:
15+n	ADCS Combined Level CMD n	TBD_{ADCS}	TBD_{ADCS}

Table 3.2.3-3 : Instrument Analog Telemetry vs. Commands

3.2.4. Telecommand Verification

The satellite will not perform any compatibility check between commands for the instrument and active instrument operational modes.

No on-board command verification will be performed for the A-DCS.

3.2.5. METOP Specific Thermal Control Electrical Interfaces

Not applicable for A-DCS.

3.2.6. Satellite Services - Synchronization

Note : Satellite Services are defined as all Command and Control tasks which will be performed by the PLM or the SVM to support instrument operations.

Note : the synchronization of measurement data read-out is defined in § 3.3.2.

Synchronization signals : N/A.

3.3. MEASUREMENT DATA TRANSFER FUNCTIONAL DESCRIPTION

3.3.1. Data Rate

Every 100 ms, the NIU acquires 93 8-bit words from the A-DCS. Hence an apparent data rate of 7440 bits per second.

These data are not packetized within the instrument.

3.3.2. Measurement Data Acquisition

The measurement data shall be acquired via the digital A data interface.

The interface shall consist of the :
- Data Enable pulse line
- Data Clock line
- Data line.

The A-DCS serial data are clocked into the NIU at a bit rate of 8.32 kbps by means of the data clock whenever the data enable pulse is presented to the instrument.

Both clock and enable pulse shall be delivered by the NIU.

The acquisition shall comply with Figure 3.3.2-1.

TBD_{ADCS} 8-bit A-DCS data are stored internally of the instrument within a memory buffer. The data is considered as a byte stream independent on internal message format. The first data word of a 32 second cycle will be available for read-out Td_{DCS} after start of the respective cycle (refer to Figure 3.3.2-1a).

Td_{DCS} defines the start of the Data Enable pulse relative to the start of the 0.1 seconds (NIU internal) cycle.

Td_{DCS} shall be $(6 * 8 * T_{8.32k} + 2 * T_{8.32k} /5)$. $T_{8.32k}$ is the time period of the 8.32 kHz Clock (CLU).
Note: Td_{DCS} is approximately 5.82 ms $\pm 10^{-4}$

During the (continuous) data acquisition, the Data Enable pulse shall repeat after Ts_{DCS}. Ts_{DCS} shall be $8 * T_{8.32k}$.
Note: Ts_{DCS} is approximately 961.5 µs $\pm 10^{-4}$

The words shall be separated by a gap in the Data Enable pulse acc. to Figure 3.3.2-1b.

The 8.32 kHz Clock is derived from a free running oscillator in the NIU. The NIU internal sync. pulses (0.1 s and 8 s) are derived in the NIU from the OBDH Bus Broadcast Pulse. The OBDH Bus Broadcast Pulse is generated by the oscillator in the CCU on the Service Module. The leading edge of the 0.1 s and the 8 s pulses will be phase correlated to the 8.32 kHz Clock.

Each of these two oscillators has its own initial setting failure, temperature drift and ageing. This will result in a tolerance of the number of clocks per 0.1 sync. pulse period as depicted in Figure 3.3.2-1a. with $T_{SA\ DCS}$.

$T_{SA\ DCS} = 0.1\ s \pm 1/8.32\ kHz$

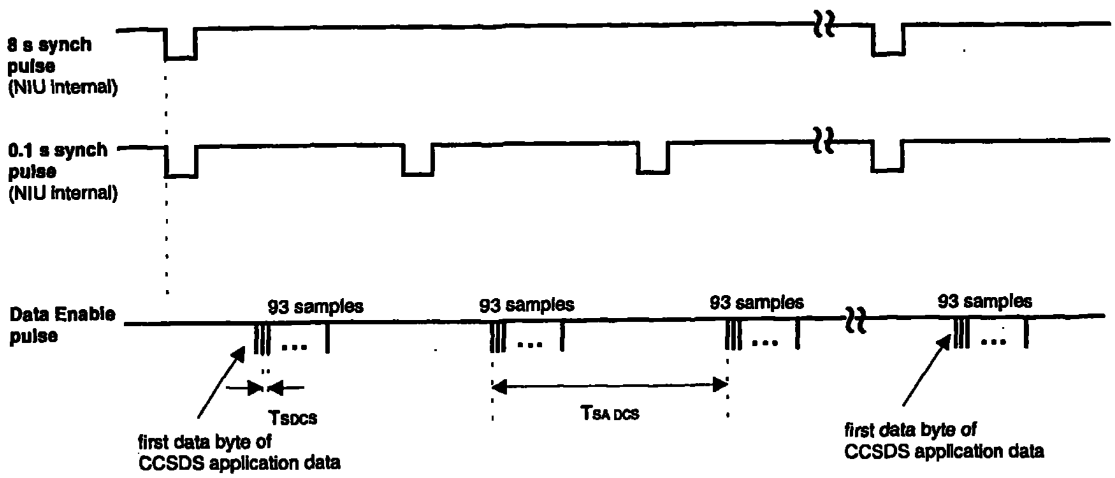


Figure 3.3.2-1a : A-DCS Measurement Data Acquisition Sampling Timing

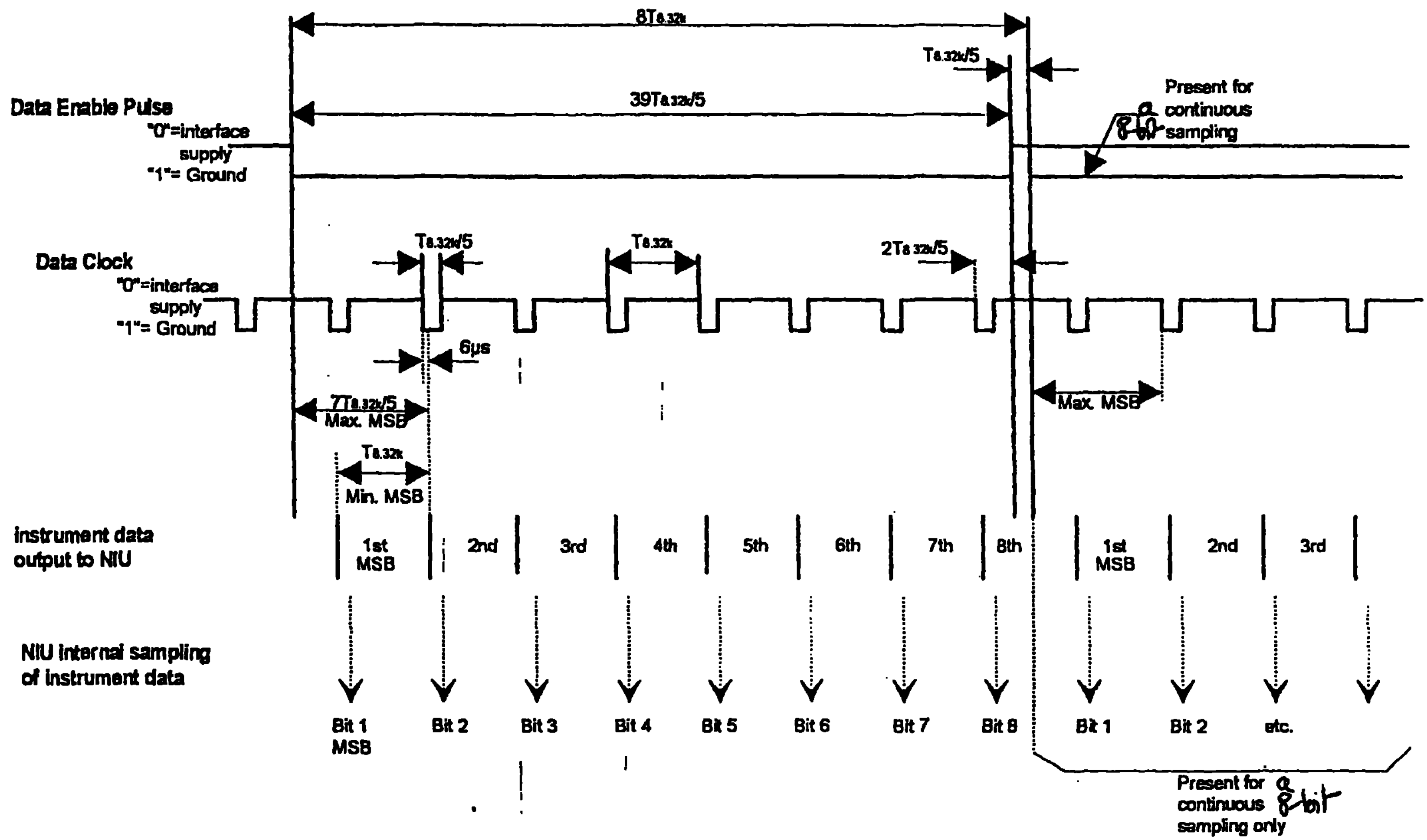


Figure 3.3.2-1b : A-DCS Measurement Data Acquisition Detailed Timing

3.3.3. Measurement (Digital A) Data Format

See AD10.

3.4. POWER ELECTRICAL INTERFACES

3.4.1. Overview

The A-DCS instrument requires the following power interfaces :

- A regulated + *28 V Main Power Bus* with high power quality as primary source for the instrument.
- A regulated + *28 V Switched TLM Bus* for powering temperature telemetry.
- A regulated + *10 V Interface Bus* for the command, clock and measurement data interface circuits.

The +28 V Main Power Bus and the + 28 V Switched TLM Bus are conditioned by the internally redundant Power Conversion Unit (PCU). The +28 V Main Power Bus is individually switched and protected. The +28 V Switched TLM Bus is powered whenever the PCU is on. The +10 V Interface Bus is provided by the NIU. This is illustrated in Fig. 3.4.1-1.

Fig. 3.4.1-2 gives details of the A-DCS internal power distribution.

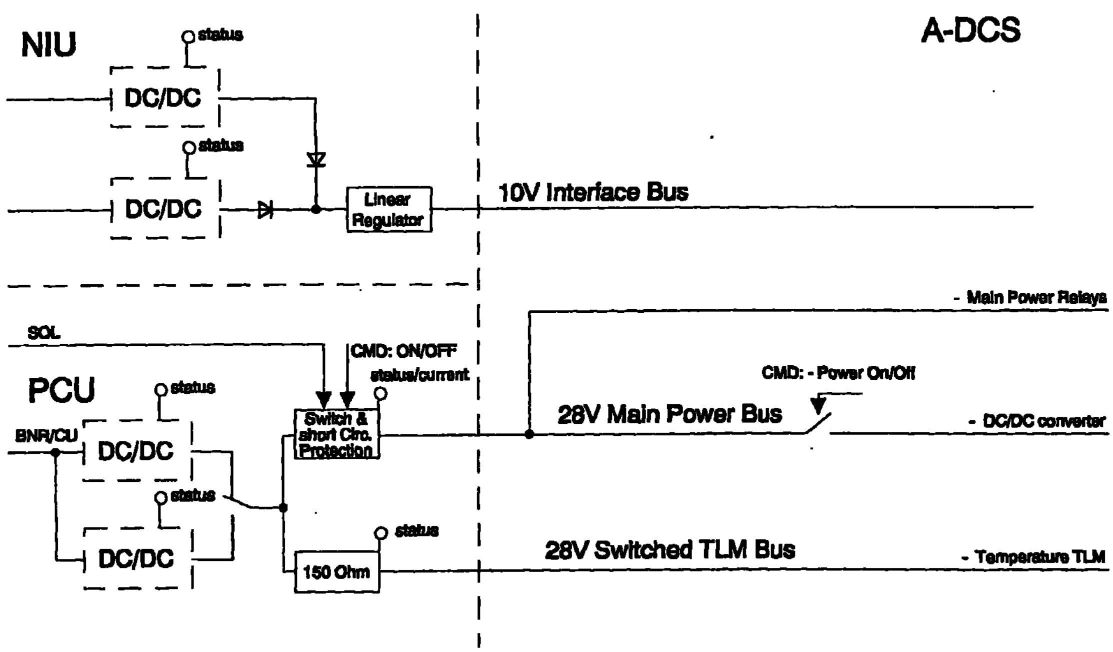


Fig. 3.4.1-1 : A-DCS Power Distribution Diagram

TBD_{ADCS}

Fig. 3.4.1-2 : A-DCS Internal Power Distribution Diagram

3.4.2. Power Demand

The actual power demands for the A-DCS on the individual power busses for BOL & EOL during all modes and required outlet dimensions are defined in Table 3.4.2-1 Power Consumption Data Sheet..

The heater power for the A-DCS units is not an instrument electrical interface and therefore not dealt within the following table.

Definitions

Typical Beginning of Life Power
Power expected to be measured during instrument acceptance test, = basic power.

Worst Case End of Life Power
Specified power the instrument shall never exceed (except in case of failure).

Mean Power
Steady state power consumed when the power bus is set at its mean voltage and with a 25 deg. C temperature.

Min. / Max Power
Min. / max. steady state power consumed as a function of power bus input voltage and instrument temperature.

Peak Power
Total power consumed during a peak, i.e. corresponding to an event of finite duration during the considered functional mode. The peak power is given at mean power bus voltage and with a 25 deg. C temperature. The peak power is characterized by a peak duration and / or a peak repetition duty cycle.

Failure Power Consumption
Maximum permanent power that will be consumed without triggering an internal protection or without leading to a fuse blowing.

dP/dV @ 25 deg. C
Mean variation of the consumed power with respect to the input voltage.

Table 3.4.2-1 : Power Consumption Data Sheet

A-DCS

dP/dV @ 25 deg. C

Instr. Mode	Power Bus	Typical Beginning of Life (W)						Worst Case End of Life (W)						
		Mean Power	Min. Power	Max. Power	Peak Power	Peak Duration	Peak Duty Cycle	Mean Power	Min. Power	Max. Power	Peak Power	Peak Duration	Peak Duty Cycle	Failure Power
Off Mode	28 V Main Bus	0	-	-	-	-	-	0	-	-	-	-	-	
	28 V Switched TM Bus	0 / 0.08 [3]	0 / 0.08	0 / 0.08	-	-	-	0 / 0.08	0 / 0.08	0 / 0.08	-	-	-	
	10 V Interface Bus	0	-	-	-	-	-	0	-	-	-	-	-	
	TOTAL	*0 / 0.08*	*0 / 0.08*	*0 / 0.08*	-	-	-	*0 / 0.08*	*0 / 0.08*	*0 / 0.08*	-	-	-	
Mission Mode	28 V Main Bus	58.50	48.00	60.30	TBD_A	TBD_A	TBD_A	58.50	48.00	60.30	TBD_A	TBD_A	TBD_A	
	28 V Switched TM Bus	00.08	0.08	0.08	-	-	-	00.08	0.08	0.08	-	-	-	
	10 V Interface Bus	00.10	0.10	0.10	-	-	-	00.10	0.10	0.10	-	-	-	
	TOTAL	*58.68*	*48.18*	*60.48*				*58.68*	*48.18*	*60.48*				
Mission Mode : Receiving Only	28 V Main Bus	34.40	28.20	35.40				34.40	28.20	35.40				
	28 V Switched TM Bus	00.08	00.08	00.08				00.08	00.08	00.08				
	10 V Interface Bus	00.10	00.10	00.10				00.10	00.10	00.10				
	TOTAL	*34.58*	*28.38*	*35.58*				*34.58*	*28.38*	*35.58*				

[3] In Off Mode, the power consumption on the Switched Temperature Telemetry bus is 0.08 W when this bus is available at the instrument interface. Otherwise it is 0 W.

3.4.3. Power Electrical Interface Requirements

In order to structure the electrical interfaces, all signals to be controlled by this document will be identified and classified into a certain number of signal types. For each signal type a three character identifier code is given as defined in the corresponding tables.

Table 3.4.3-1 shows the power interfaces used by the A-DCS and the corresponding data sheet identifiers.

	Data Sheet Code	Interface Circuit
+28 V Main Power Bus ADCS	APB	Fig. 3.4.3.2-1
+28 V Switched TLM Bus ADCS	BPB	Fig. 3.4.3.2-2
+10 V Interface Bus ADCS	DPB	Fig. 3.4.3.2-3

Table 3.4.3-1 : A-DCS Power Interfaces

Within the Power Interface Data Sheets in § 3.4.3.1 the electrical characteristics of the power interfaces are defined.

3.4.3.1. Power Interface Data Sheets

On the following pages the electrical characteristics of the power interfaces are defined with one Data Sheet per signal. In Table 3.4.3-1 : 'A-DCS Power Interfaces' and § 3.4.5 'Power Pin Allocation Lists' is referenced to these Data Sheets.

The performances specified in the Data Sheets are maintained during the mission lifetime and under nominal load and temperature range conditions. Source specifications have to be measured at the connector of the source and load specifications have to be measured at the connector of the load unless specified otherwise.

Parameter Definitions

Small Signal Impedance
Output impedance of the power supply tested with, compared to 28V, small AC signals.

Output Impedance
Linear output impedance of the power supply.

Voltage Ripple
Sinusoidal voltage ripple, including repetitive spikes and voltage drop caused by the instruments current ripple.

Under-Voltage (incl. ripple & trans.)
The specified voltage range will be considered as under-voltage.

Over-Voltage (incl. ripple & trans.)

The specified voltage range will be considered as over-voltage.

Transients

Positive or negative going, non repetitive spikes caused by load current changes.

Max. Steady-State Current

Maximum power as defined in the Power Consumption Data Sheet, divided by the minimum specified nominal voltage.

Current Ripple

Ripple caused by the load pulsed currents (DC/DC converter, stepper motors...).

Inrush Current

Maximum allowed input current for a restricted time, when the load is switched on.

Inrush Current Rate

Rate-of-change of the input current over time when the load is switched 'on'.

Signal Nomenclature	**28 V Main Power Bus**	
Code	APB	
EMC Class	Power	
Power Source Specification		
Parameter	**Requirement**	**Remarks**
Voltage	27.16 ... 28.84 V	at A-DCS input
Small Signal Impedance	< 0.3 Ω	f < 100 kHz, short circuit protection & line < 0.1Ω
Voltage Ripple	See § 4.3.1.2	
Under-Voltage (incl. ripple & trans.)	> 16 V ; < 27.16 V	for < 3 s
Over-Voltage (incl. ripple & trans.)	> 28.84 V ; < 38.0 V	for < 50 ms
Transients	See § 4.3.1.2	
Max. Current	< 5.0 A	Limited by short circuit protection
Leakage Current	< 6 mA	Short circuit protection 'Off'
Load Specification		
Parameter	**Requirement**	**Remarks**
Max. Steady-State Current	See Table 3.4.2-1	$I_{MAX} = P_{MAX} / 27.16$ V
Current Ripple	< 2% Max Steady-State Curr.	f < 200 kHz
Inrush Current:	< 150% Max. Steady-State Curr.	Steady- State after 60 ms
Inrush Current Rate	< 30 mA/µs	
Harness Design		
Parameter	**Requirement**	**Remarks**
Wiring Type	T8-20	

Signal Nomenclature	+28 V Switched TLM Bus	
Code	BPB	
EMC Class	Power	
Power Source Specification:		
Parameter	**Requirement**	**Remarks**
Voltage	27.16 ... 28.84 V	at A-DCS input [4]
Small Signal Impedance	< 160 Ω	f < 100 kHz
Voltage Ripple	See § 4.3.1.2	
Under-Voltage (incl. ripple & trans.)	> 16.00 ; < 27.16 V	for < 3 s
Over-Voltage (incl. ripple & trans.)	> 28.84 ; < 38.00 V	for < 50 ms
Transients	See § 4.3.1.2	
Load Specification		
Parameter	**Requirement**	**Remarks**
Max. Steady-State Current	See Table 3.4.2-1	$I_{MAX} = P_{MAX} / 27.16$ V
Current Ripple	< 1 mA_{pp}	f < 200 kHz
Inrush Current	<150% of Max Stdy-State Curr.	Steady-State after 30 ms
Harness Design		
Parameter	**Requirement**	**Remarks**
Wiring Type	TP24	

[4] Measured under no load condition.

Signal Nomenclature	+10 V Interface Bus	
Code	DPB	
EMC Class	Power	
Power Source Specification:		
Parameter	**Requirement**	**Remarks**
Voltage	9.5 ... 10.5 V	at A-DCS input
Source Current	< 10 mA	
Small Signal Impedance	< 1 Ω	f < 10 MHz
Voltage Ripple	See § 4.3.1.2.	
Under-Voltage (incl. ripple & trans.):	> 9.0 V ; < 9.5 V	
Over-Voltage (incl. ripple & trans.):	> 10.5 V ; < 15.0 V	
Voltage Transients:	See § 4.3.1.2.	
Load Specification		
Parameter	**Requirement**	**Remarks**
Max. Steady-State Current	See Table 3.4.2-1	$I_{MAX} = P_{MAX} / 9.5$ V
Current Ripple	< 1 mA_{pp}	f < 2.5 MHz
Inrush Current	<125% of Max Stdy-State Cur.	for < 60 ms
Harness Design		
Parameter	**Requirement**	**Remarks**
Wiring Type	TP20	

3.4.3.2. Power Interface Circuits

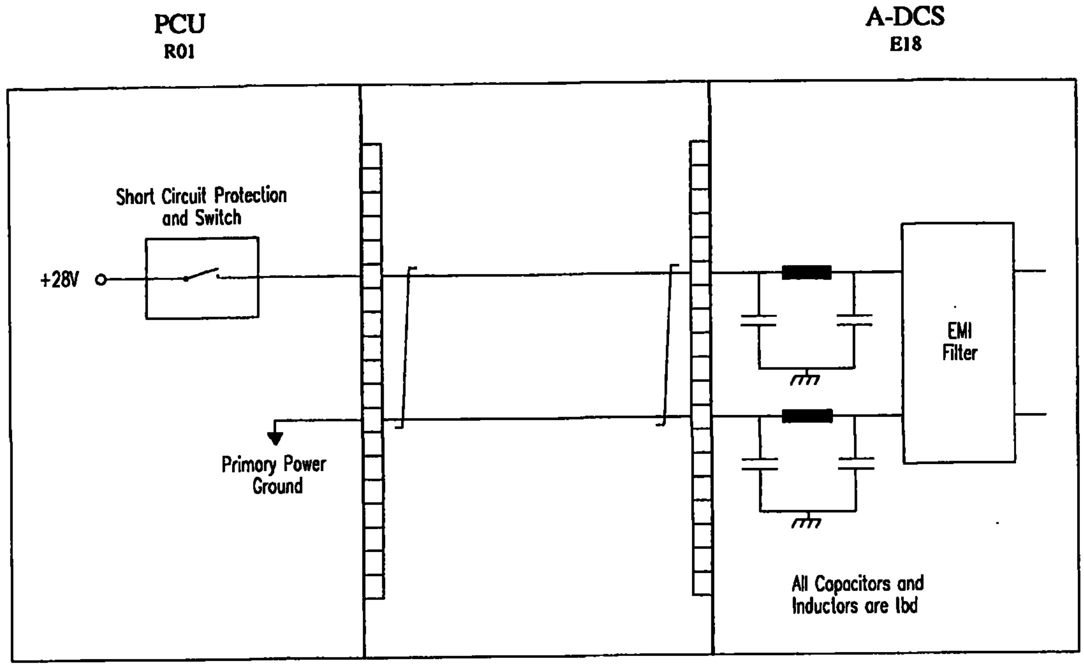


Fig. 3.4.3.2-1 : +28 V Main Power Bus Interface Circuit

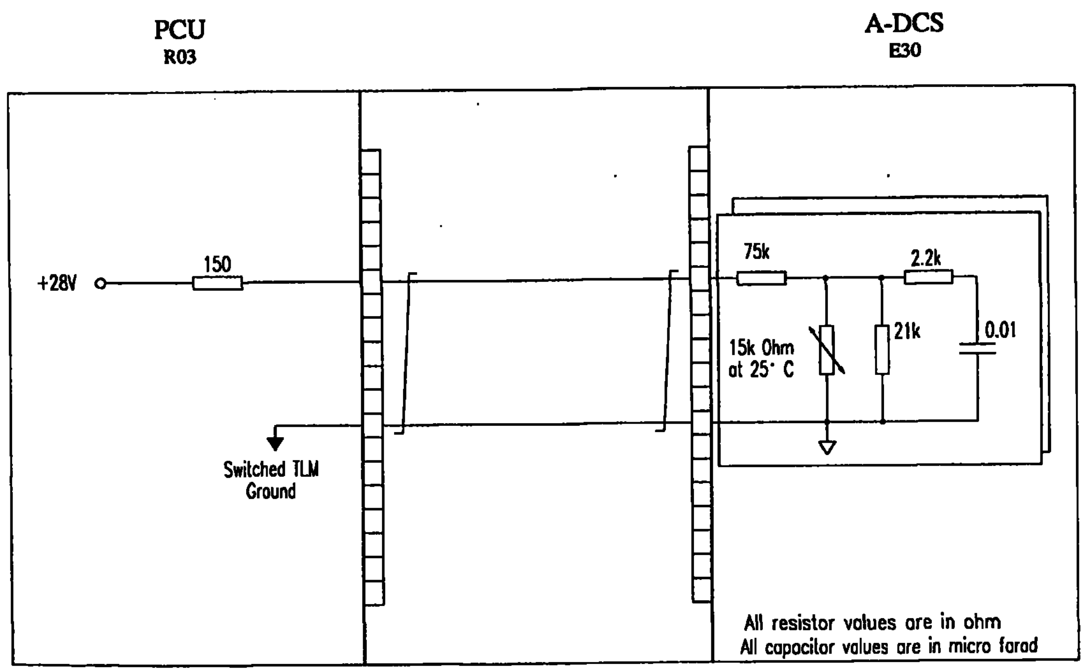


Fig. 3.4.3.2-2 : +28 V Switched TLM Bus Interface Circuit

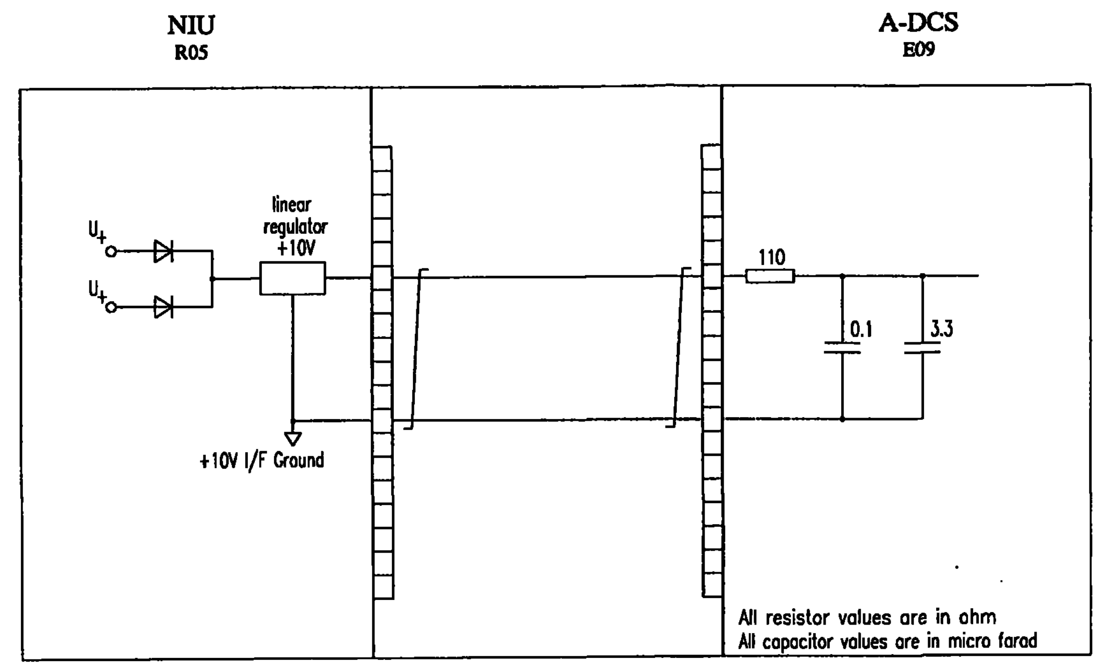


Fig. 3.4.3.2-3 : +10 V Interface Bus Interface Circuit

3.4.4. Power Connectors

Table 3.4.4-1 identifies the power connector types at the A-DCS boxes and Table 3.4.4-2 identifies the power connector types at the A-DCS harness.

Table 3.4.4-1 : Power Connector Types at A-DCS (RPU) Boxes

Connector	Connector-Type	Function
J208	DAMA-15P	Power

Table 3.4.4-2 : Power Connector Types at A-DCS (RPU) Harness

Connector	Connector-Type	Function
P208	DAMA-15S-NMB	Power

3.4.5. Power Pin Allocation Lists

In these lists, the cross reference between connector pin, signal designation, Interface Data Sheet, target connector and target connector pin is defined and recorded as data base. Per connector one list is prepared.

Interface Data Sheets can be found in § 3.4.3.1.

The individual pin allocation lists are specified by 10 characters of a alpha numerical connector number. For the A-DCS the first 5 characters are NADCS. Character 6 is reserved. The 7th character is J for a box connector or P for a harness connector. The last three characters define the connector number.

Since these lists also specify wiring and shielding, they will form the basis for harness manufacturing.

The power connector pin allocations at instrument level are described in AD8. The power connector harness are described in Table 3.4.5/2.

Connector : NADCS- P208 Item : A-DCS Function : Power Conn.-Type : DAMA-15S-NMB
EMC-Category : 1 Location : 2F

			Interface-Code			Grouping									
Pin	Signal Designation		Circ	Signal	Pos.	Ch. ID	Wiring	Shd	Cable	Twist	Comment	End-It.	Loc.	Connector	Pin
01	+28V MainPwr Bus DCS	SUP1		APB.2	-	AP00	T4-20					PCU	2C	PPCU P03	09
09	+28V MainPwr Bus DCS	RTN1		APB.2	-	AP00	T4-20					PCU	2C	PPCU P03	03
02	+28V MainPwr Bus DCS	SUP2		APB.2	-	AP00	T4-20					PCU	2C	PPCU P03	27
10	+28V MainPwr Bus DCS	RTN2		APB.2	-	AP00	T4-20					PCU	2C	PPCU P03	21
01	+28V MainPwr Bus DCS	SUP3		APB.2	-	AP00	T4-20					PCU	2C	PPCU P03	28
09	+28V MainPwr Bus DCS	RTN3		APB.2	-	AP00	T4-20					PCU	2C	PPCU P03	22
02	+28V MainPwr Bus DCS	SUP4		APB.2		AP00	T4-20					PCU	2C	PPCU P03	28
10	+28V MainPwr Bus DCS	RTN4		APB.2		AP00	T4-20					PCU	2C	PPCU P03	22
03	+28V SW TLM Bus DCS	SUP		BPB.-		BP00	TP-24				Pin 3 and pin 4 are	PCU	2C	PPCU P03	19
11	+28V SW TLM Bus DCS	RTN		BPB.-		BP00	TP-24				shorted at the P-conn.	PCU	2C	PPCU P03	17
04	Bridge to pin 03										Pin 11 and pin 12 are				
12	Bridge to pin 11										shorted at the P-conn.				
05	Signal GND														
06	Signal GND														
07	NC														
08	NC														
13	NC														
14	NC				-										
15	NC				-										
BS	OVERALL SHD											PCU	2C	PPCU P03	BS

Table 3.4.5/2 : Pin Allocation List of Connector P208

(For Information Only)

3.5. SIGNAL ELECTRICAL INTERFACES

3.5.1. Overview

An overview on the A-DCS signal is presented in Fig. 3.5-1.

Signal interfaces with the PLM units are specified in § 3.5.2.
Signal interfaces with the RFF and the DTA and A-DCS internal interfaces are specified in § 3.5.3.

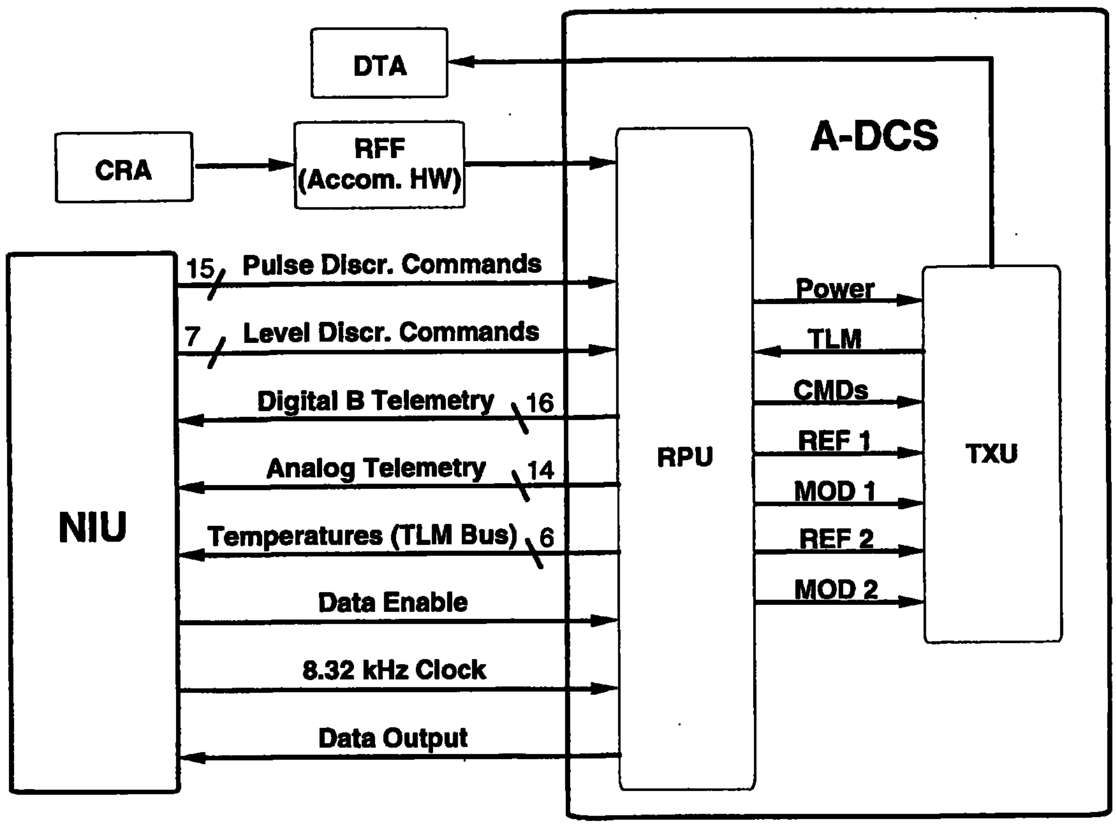


Fig. 3.5-1 : A-DCS Signal Interface

3.5.2. Signal Interfaces With PLM Units

3.5.2.1. Signal Interface Requirements (Interfaces With PLM Units)

Table 3.5.2.1-1 lists all signals of the A-DCS signal electrical interface with the PLM and gives references to the Interface Data Sheets in § 3.5.2.1.1 and the interface circuits in § 3.5.2.1.2.

Table 3.5.2.1-1 : Signal to Data Sheets & Interface Circuits Assignments (1/2)

Signal	Data Sheet Code	Interface Circuit	Remarks
ADCS RX1 Select ADCS RX2 Select ADCS RX1 Power Supply On ADCS RX1 Power Supply Off ADCS RX2 Power Supply On ADCS RX2 Power Supply Off ADCS TX1 Select ADCS TX2 Select ADCS TX1 Power Supply On ADCS TX1 Power Supply Off ADCS TX2 Power Supply On ADCS TX2 Power Supply Off ADCS Software Restart ADCS Uploading Authorization ADCS Strobe Level Commands	CCP	Fig. 3.5.2.1.2-1	Pulse Discrete Commands
ADCS Level CMD 0 ADCS Level CMD 1 ADCS Level CMD 2 ADCS Level CMD 3 ADCS Level CMD 4 ADCS Level CMD 5 ADCS Level CMD 6	CCL	Fig. 3.5.2.1.2-1	Level Discrete Commands
ADCS Status RX Power Select ADCS Status TX Power Select ADCS Status RX Antenna Select	TLD	Fig. 3.5.2.1.2-2	Digital B HK Telemetry
ADCS Status RX1 On / Off ADCS Status RX2 On / Off ADCS Status TX1 On / Off ADCS Status TX2 On / Off		Fig. 3.5.2.1.2-3	
ADCS Status TX Antenna Select		Fig. 3.5.2.1.2-4	
Status ADCS Data 0 Status ADCS Data 1 Status ADCS Data 2 Status ADCS Data 3 Status ADCS Data 4 Status ADCS Data 5 Status ADCS Data 6 Status ADCS Data 7		Fig. 3.5.2.1.2-5	

Table 3.5.2.1-1 : Signal to Data Sheets & Interface Circuits Assignments (2/2)

<table>
<tr><th>Signal</th><th>Data Sheet Code</th><th>Interface Circuit</th><th>Remarks</th></tr>
<tr><td>ADCS RPU Power Volt. +5 V
ADCS RPU Power Voltage +12 V
ADCS TXU Power Volt. +5 V
ADCS TXU Power Voltage +12 V
ADCS Tx Amplifier DC Current</td><td rowspan="4">TLA</td><td>Fig. 3.5.2.1.2-6</td><td rowspan="2">Analog HK Telemetry</td></tr>
<tr><td>ADCS RPU Power Volt. -5 V
ADCS RPU Power Voltage -12 V
ADCS TXU Power Volt. -5 V
ADCS TXU Power Voltage -12 V
ADCS OCXO Oven Current
ADCS OCXO Output Level
ADCS Power Transmitter Output Power
ADCS RPU Power Converter Temp.
ADCS TXU Power Converter Temp.</td><td>Fig. 3.5.2.1.2-7</td></tr>
<tr><td>ADCS RPU Temperature
ADCS TXU Temperature</td><td>Fig. 3.5.2.1.2-8</td><td rowspan="2">Temperatures (Switched TLM Bus)</td></tr>
<tr><td>ADCS Temperature Spare 0
ADCS Temperature Spare 1
ADCS Temperature Spare 2
ADCS Temperature Spare 3</td><td>N/A (see note)</td></tr>
<tr><td>Data Enable A-DCS</td><td>DEN</td><td rowspan="2">Fig. 3.5.2.1.2-9</td><td rowspan="3">Timing see § 3.3 Measurement Data</td></tr>
<tr><td>Data Output A-DCS</td><td>DOA</td></tr>
<tr><td>8.32 kHz Clock A-DCS</td><td>CLU</td><td>Fig. 3.5.2.1.2-10</td></tr>
</table>

Note - Non allocated or spare housekeeping telemetry : see § 3.2.3.1.

3.5.2.1.1. Signal Interface Data Sheets (Interfaces With PLM Units)

On the following pages, the electrical characteristics of signal electrical interfaces are defined with one Data Sheet per signal. In § 3.5.2.1 'Signal Interface Requirements' and § 3.5.2.3 'Signal Pin Allocation Lists' is referenced to these Data Sheets.

The performances specified in the Data Sheets are maintained during the mission lifetime and under nominal load and temperature range conditions. Source specifications have to be measured at the connector of the source and load specifications have to be measured at the connector of the load unless specified otherwise.

The Fault Voltage Protection is the maximum externally induced voltage that the specified input or output can withstand without damage. The Fault Voltage Emissions is the maximum internally generated voltage that the specified input or output can create under worst case fault conditions.

Signal Nomenclature	Pulse Discrete Commands (Short)	
Code	CCP	
EMC Class	Signal	
Source Circuit Specification		
Parameter	**Requirement**	**Remarks**
'1' - Level / 'TRUE'	-0.2 ... +0.2 V	line to 10 V I/F ground
'0' - Level / 'FALSE' (V_{OH})	+9.3 ... +10.7 V	line to 10 V I/F ground
Rise Time 10% to 90%	< 12 µs	cable length < 5 m
Fall Time 90% to 10%	< 12 µs	cable length < 5 m
Pulse Duration	55 ... 65 ms	'1' - Level
Output Impedance	< 1.5 kΩ	R (CMOS output) + 200 Ω
Source Current	> 1 mA	@ V_{OH} = 9.5 V
Fault Voltage Emissions	0 V ... V_{DD}	R_S > 100 Ω
Fault Voltage Protection	-0.5 V ... V_{DD} + 0.5 V	V_{DD} see Note
Load Circuit Specification		
Parameter	**Requirement**	**Remarks**
'1' - Level	-0.5 ... +2 V	line to 10 V I/F ground
'0' - Level	+8.0 ... +10.8 V	line to 10 V I/F ground
Sink Current	< 1 mA	
Input Impedance	> 90 kΩ	
Fault Voltage Emissions	0 V ... V_{DD}	R_S > 2 kΩ
Fault Voltage Protection	-0.5 V ... V_{DD} + 0.5 V	V_{DD} see Note
Harness Design		
Parameter	**Requirement**	**Remarks**
Wiring Type	AWG 24, single line	return via +10 V I/F ground

Note : V_{DD} is the common supply voltage for the source and the load circuit.
Definition of V_{DD} : see Data Sheet '+ 10 V Interface Bus - DPB' in § 3.4.3.1.

Signal Nomenclature	**Level Discrete Commands**	
Code	CCL	
EMC Class	Signal	
Source Circuit Specification		
Parameter	**Requirement**	**Remarks**
'1' - Level (= True = 0 VDC)	-0.2 ... +0.2 V	line to 10 V I/F ground
'0'-Level (= False = 10 VDC ; V_{OH})	+9.3 ... +10.7 V	line to 10 V I/F ground
Rise Time 10% to 90%	< 12 µs	cable length < 5 m
Fall Time 90% to 10%	< 12 µs	cable length < 5 m
Output Impedance	< 1.5 kΩ	R (CMOS output) + 200 Ω
Source Current	> 1 mA	@ V_{OH} = 9.5 V
Fault Voltage Emissions	0 V ... V_{DD}	R_S > 100 Ω
Fault Voltage Protection	-0.5 V ... V_{DD} + 0.5 V	V_{DD} defined in Data Sheet CCP
Load Circuit Specification		
Parameter	**Requirement**	**Remarks**
'1' - Level	-0.5 ... +2 V	line to 10 V I/F ground
'0' - Level	+8.0 ... +10.8 V	line to 10 V I/F ground
Sink Current	< 1 mA	
Input Impedance	> 90 kΩ	
Fault Voltage Emissions	0 V ... V_{DD}	R_S > 2 kΩ
Fault Voltage Protection	-0.5 V .... V_{DD} + 0.5 V	V_{DD} defined in Data Sheet CCP
Harness Design		
Parameter	**Requirement**	**Remarks**
Wiring Type	AWG 24, single line	return via +10 V I/F ground

Signal Nomenclature	**Digital B Telemetry**	
Code	TLD	
EMC Class	Signal	
Source Circuit Specification		
Parameter	**Requirement**	**Remarks**
'1' - Level	-0.1 ... +0.5 V	Ground reference
'0' - Level	+3.5 ... +5.7 V	See interface circuit
Spectral Frequency Range	0 ... 200 Hz	for f > 200 Hz filter required ; sampling rate see under Load
Output Impedance	2 kΩ ... 15 kΩ	
Source Current	> 60 µA	
Fault Voltage Emissions	-15 ... +15 V	R_S > 0.2 kΩ
Fault Voltage Protection	-15 ... +15 V	R_S > 0.2 kΩ
Load Circuit Specification		
Parameter	**Requirement**	**Remarks**
'1' - Level	-0.2 ... +0.8 V	line to 10 V I/F ground
'0' - Level	+3.0 ... +5.7 V	line to 10 V I/F ground
Sink Current	< 60 µA	
Sampling Rate	0.125 ... 16 s	
Fault Voltage Emissions	-15 ... +15 V	R_S > 0.2 kΩ
Fault Voltage Protection	-15 ... +15 V	
Input Impedance	>100 kΩ	
Harness Design		
Parameter	**Requirement**	**Remarks**
Wiring Type	AWG 24, single line	return via 10 V I/F ground

Signal Nomenclature	**Analog HK Telemetry**	
Code	TLA	
EMC Class	Signal	
Source Circuit Specification		
Parameter	**Requirement**	**Remarks**
Voltage Range	0 ... 5.12 V	load > 2 MΩ
Spectral Frequency Range	0 ... 200 Hz	for f > 200 Hz filter required ; sampling rate see under Load
Output Impedance	2 kΩ ... 15 kΩ	
Source Current	> 3 μA	
Fault Voltage Protection	-15 ... +15 V	R_S > 2 kΩ
Fault Voltage Emissions	-15 ... +15 V	R_S > 2 kΩ
Load Circuit Specification		
Parameter	**Requirement**	**Remarks**
Input Voltage Range	0 ... 5.12 V	Line to return
Sampling Rate	0.125 ... 16 s	
Conversion Resolution	8 bit	20 mV/LSB
Measurement Accuracy	20 mV	
Sink Current	< 3 μA	
Fault Voltage Protection	-15 ... +15 V (EM) -15 ... +28V (FM)	
Fault Voltage Emissions	-15 ... +15 V	R_S > 2 kΩ
Input Impedance	> 2 MΩ	
Harness Design		
Parameter	**Requirement**	**Remarks**
Wiring Type	AWG 24, Single Line	Return via Signal Ground or Sw. TLM Ground (See I/F Circuits)

Signal Nomenclature	**Data Enable**	
Code	DEN	
EMC Class	Signal	
Source Circuit Specification		
Parameter	**Requirement**	**Remarks**
'1' - Level	-0.2 ... +0.2 V	line to 10 V I/F ground
'0' - Level (V_{OH})	+9.3 ... +10.7 V	line to 10 V I/F ground
Number of Samples	93 per 100 ms	
Stability	derived from 8.32 kHz Clock	see Data Sheet CLU
Pulse Width	(39/5) x (1/8.32 kHz Clock)	at '1' - Level
Rise Time 10% to 90%	< 2 µs	cable length < 5 m
Fall Time 90% to 10%	< 2 µs	cable length < 5 m
Output Impedance	< 1.5 kΩ	R (CMOS output) + 200 Ω
Source Current Requirement	Deleted (not relevant for the instrument)	
Fault Voltage Emissions	0 V ... V_{DD}	R_S > 100 Ω
Fault Voltage Protection	-0.5 V ... V_{DD} + 0.5 V	V_{DD} defined in Data Sheet CCP
Load Circuit Specification		
Parameter	**Requirement**	**Remarks**
'1' - Level	-0.5 ... +2 V	line to 10 V I/F ground
'0' - Level	+8.0 ... +10.8 V	line to 10 V I/F ground
Sink Current	< 1 mA	
Input Impedance	> 90 kΩ	
Fault Voltage Emissions	0 V ... V_{DD}	R_S > 2 kΩ
Fault Voltage Protection	-0.5 V ... V_{DD} + 0.5 V	V_{DD} defined in Data Sheet CCP
Harness Design		
Parameter	**Requirement**	**Remarks**
Wiring Type	AWG 24, single line	return via 10 V I/F ground

Signal Nomenclature	**Data Output**	
Code	DOA	
EMC Class	Signal	
Source Circuit Specification:		
Parameter	**Requirement**	**Remarks**
'1' - Level:	-0.2 ... +0.2 V	line to 10 V I/F ground
'0' - Level (V_{OH})	+9.3 ... +10.7 V	line to 10 V I/F ground
Data Word Rate (Burst)	93 x 8-bit words per 100 ms	
Rise Time 10% to 90%	< 2 µs	cable length < 5 m
Fall Time 90% to 10%	< 2 µs	cable length < 5 m
Output Impedance	< 1.5 kΩ	R (CMOS output) + 200 Ω
Source Current	> 1 mA	@ V_{OH} = 9.5 V
Fault Voltage Emissions	0 V ... V_{DD}	R_S > 100 Ω
Fault Voltage Protection	-0.5 V ... V_{DD} + 0.5 V	V_{DD} defined in Data Sheet CCP
Load Circuit Specification		
Parameter	**Requirement**	**Remarks**
'1' - Level	-0.5 ... +2 V	line to 10 V I/F ground
'0' - Level	+8.0 ... +10.8 V	line to 10 V I/F ground
Sink Current	< 1 mA	
Input Impedance	> 90 kΩ	
Fault Voltage Emissions	0 V ... V_{DD}	R_S > 2 kΩ
Fault Voltage Protection	-0.5 V ... V_{DD} + 0.5 V	V_{DD} defined in Data Sheet CCP
Harness Design		
Parameter	**Requirement**	**Remarks**
Wiring Type	AWG 24, single line	return via 10 V I/F ground

Signal Nomenclature	8.32 kHz Clock	
Code	CLU	
EMC Class	Signal	
Source Circuit Specification		
Parameter	**Requirement**	**Remarks**
'1' - Level	-0.2 ... +0.2 V	line to 10 V I/F ground
'0' - Level (V_{OH})	+9.3 ... +10.7 V	line to 10 V I/F ground
Repetition Rate	8.32 kpps ± 0.01 %	
Stability	< 5.10^{-9} / sec	
Frequency Drift per Week	< 5.10^{-6}	over temperature range
Frequency Drift per Year	< 1.10^{-6}	at constant temperature
Pulse Width	24 µs ± 1.7 µs	at '1' - Level
Rise Time 10% to 90%	< 2 µs	cable length < 5 m
Fall Time 90% to 10%	< 2 µs	cable length < 5 m
Output Impedance	< 1.5 kΩ	R (CMOS output) + 200 Ω
Source Current Requirement	Deleted (not relevant for the instrument)	
Fault Voltage Emissions	0 V ... V_{DD}	R_S > 100 Ω
Fault Voltage Protection	-0.5 V ... V_{DD} + 0.5 V	V_{DD} defined in Data Sheet CCP
Load Circuit Specification		
Parameter	**Requirement**	**Remarks**
'1' - Level	-0.5 ... +2 V	line to 10 V I/F ground
'0' - Level	+8.0 ... +10.8 V	line to 10 V I/F ground
Sink Current	< 1 mA	
Input Impedance	> 15 kΩ	
Fault Voltage Emissions	0 V ... V_{DD}	R_S > 2 kΩ
Fault Voltage Protection	-0.5 V ... V_{DD} + 0.5 V	V_{DD} defined in Data Sheet CCP
Harness Design		
Parameter	**Requirement**	**Remarks**
Wiring Type	AWG 24, single line	line to 10 V I/F ground

3.5.2.1.2. Signal Interface Circuits (Interfaces With PLM Units)

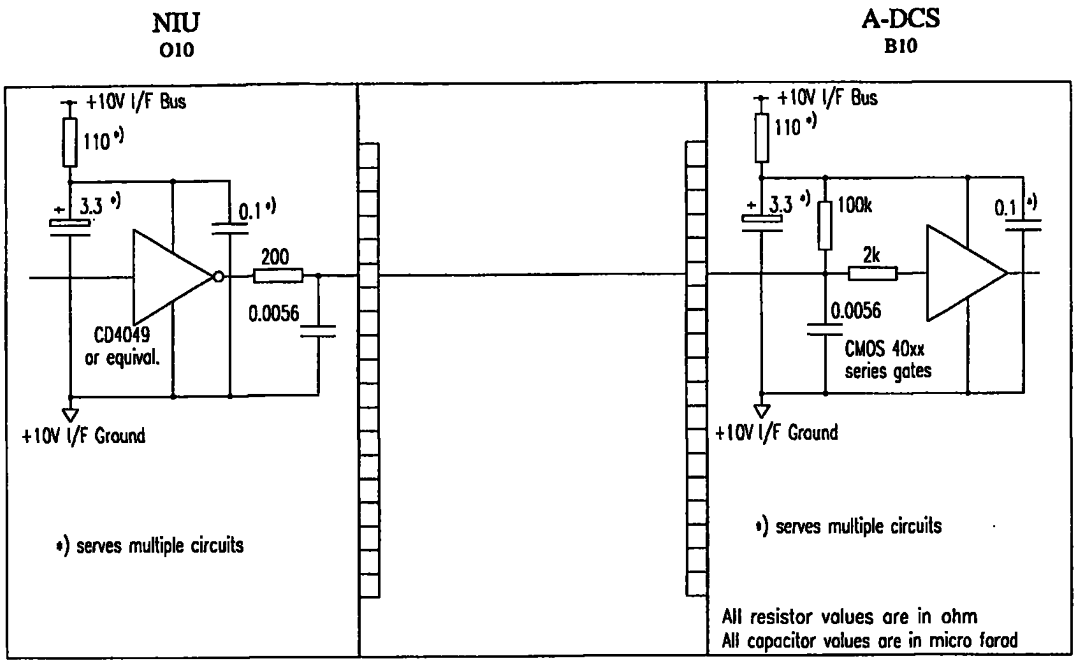


Fig. 3.5.2.1.2-1 : A-DCS Pulse and Level Discrete Command Interface Circuit

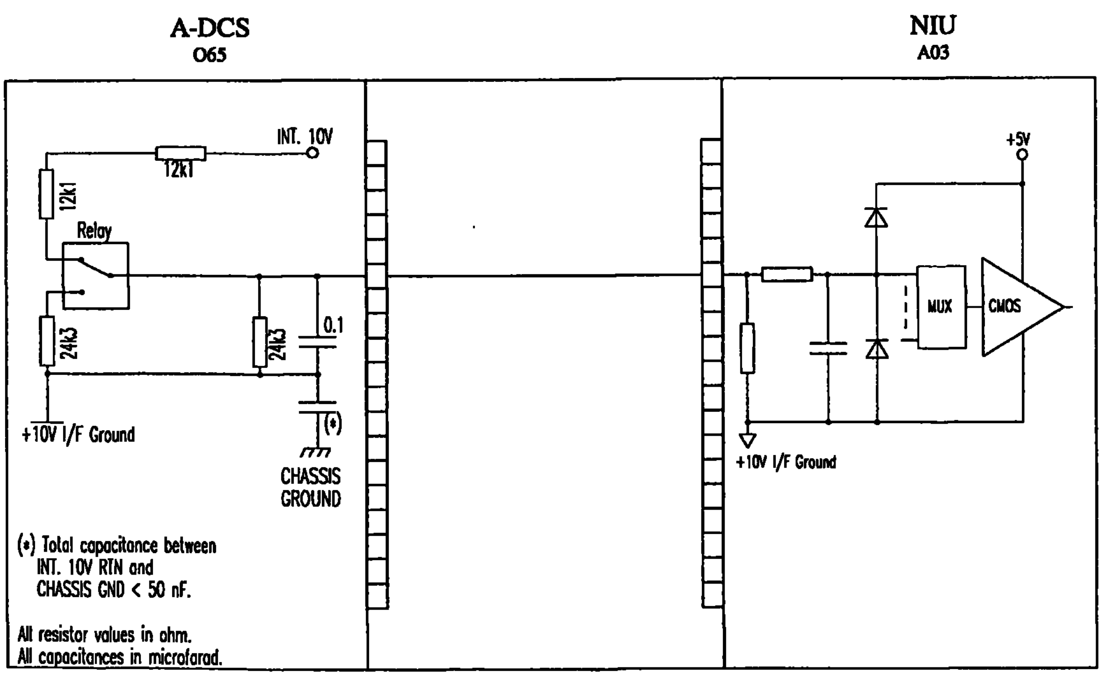


Fig. 3.5.2.1.2-2 : A-DCS Digital B Telemetry Relay Status Interface Circuit

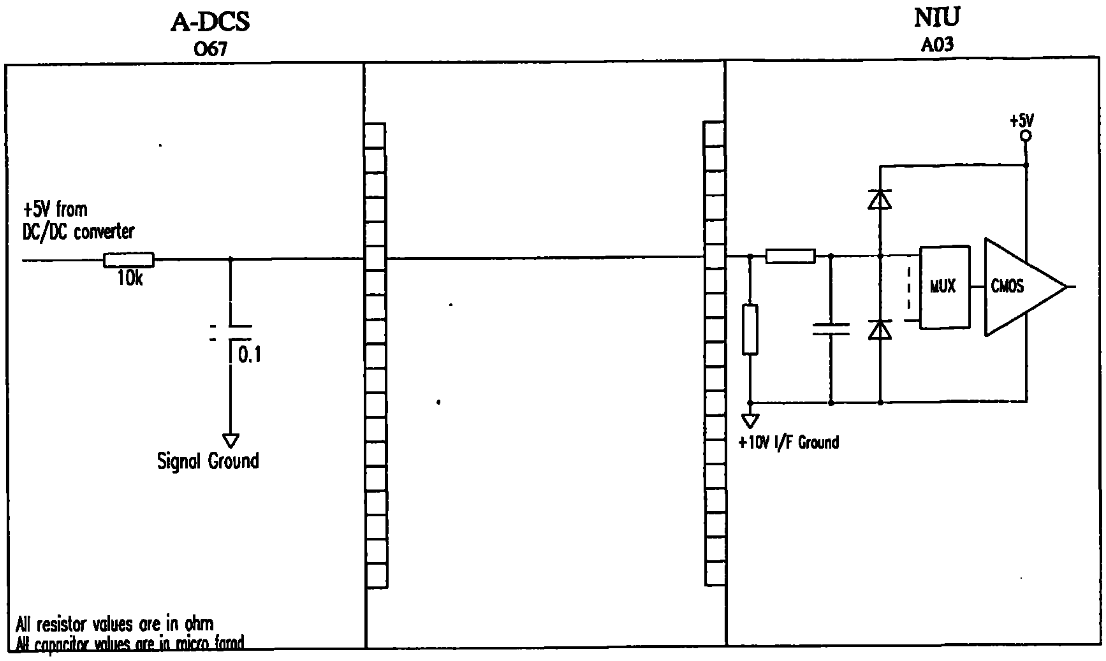
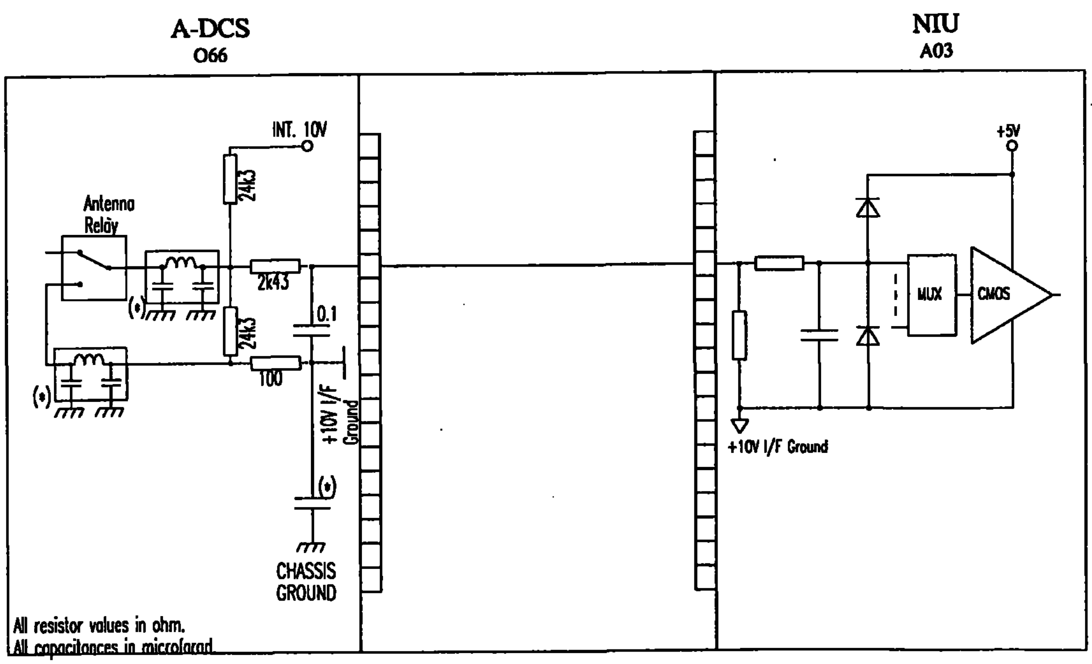
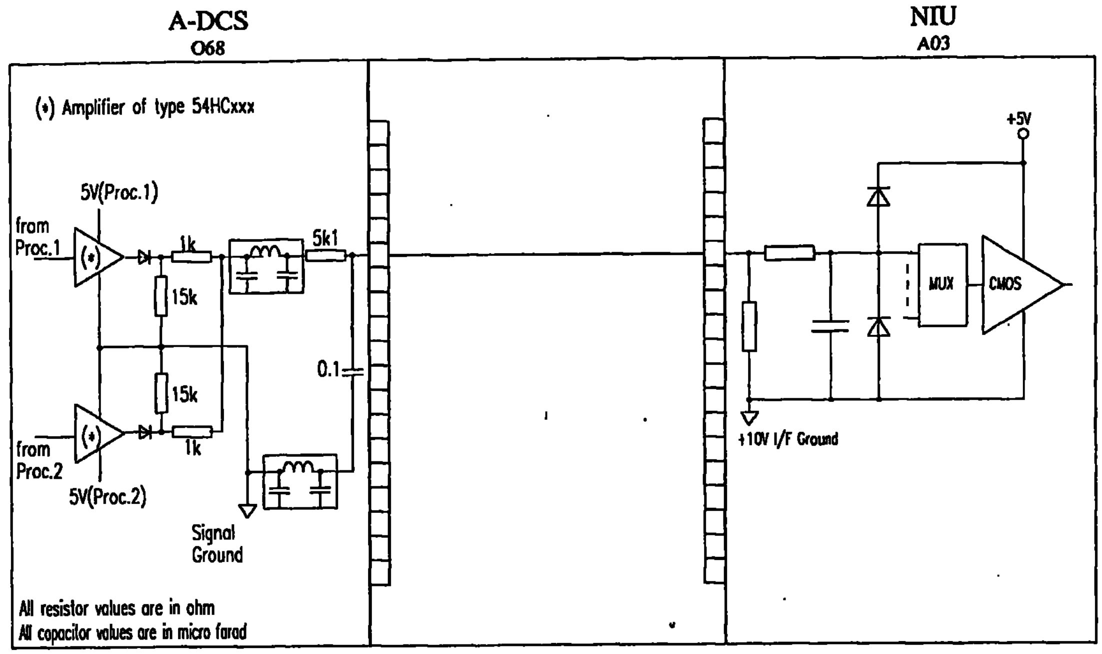


Fig. 3.5.2.1.2-3 : A-DCS Digital B Telemetry On / Off Status Interface Circuit



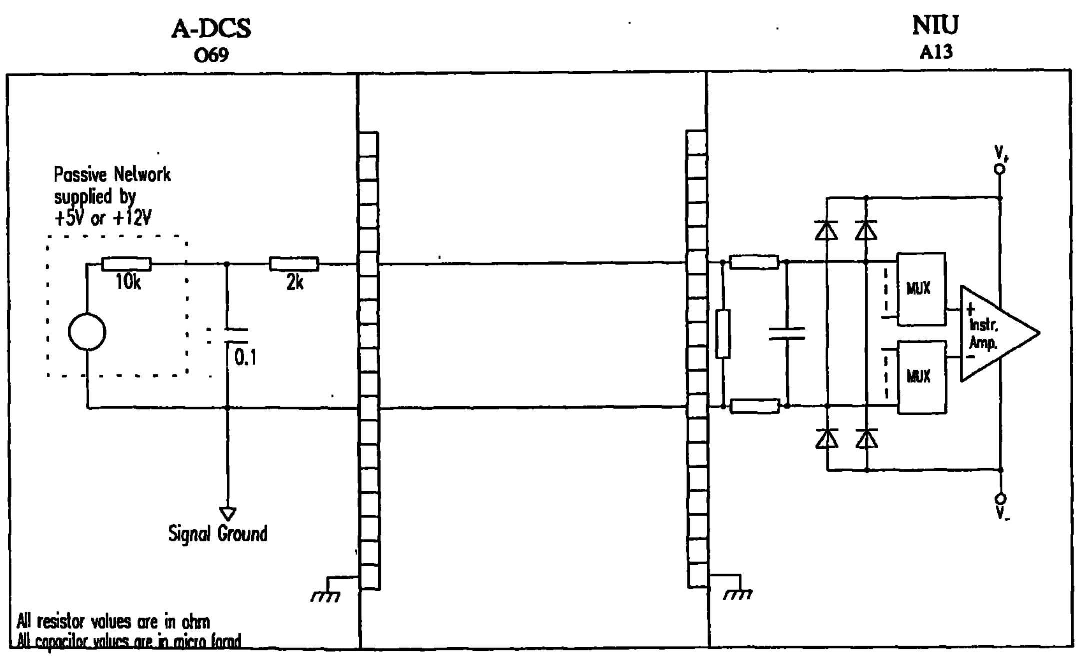
(*) : Total capacitance between INT. 10V RTN and CHASSIS GND < 50 nF.

Fig. 3.5.2.1.2-4 : A-DCS Digital B Telemetry TX Relay Antenna Select Status Interface Circuit



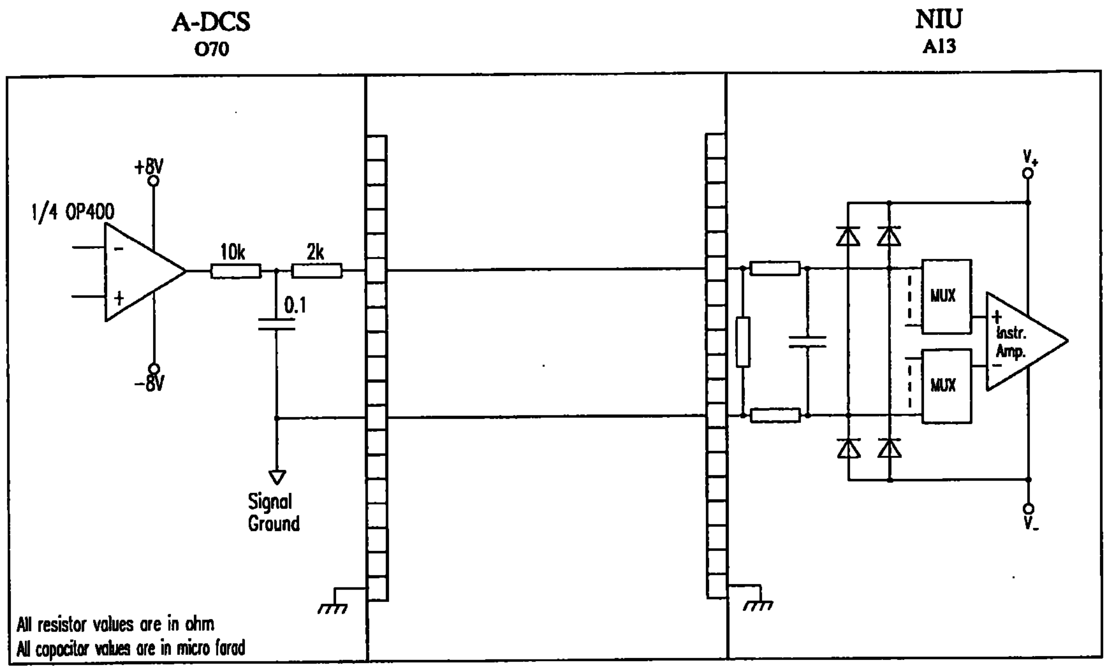
Note : Proc. = Processor

Fig. 3.5.2.1.2-5 : A-DCS Digital B Telemetry Processing (Data) Status Interface Circuit



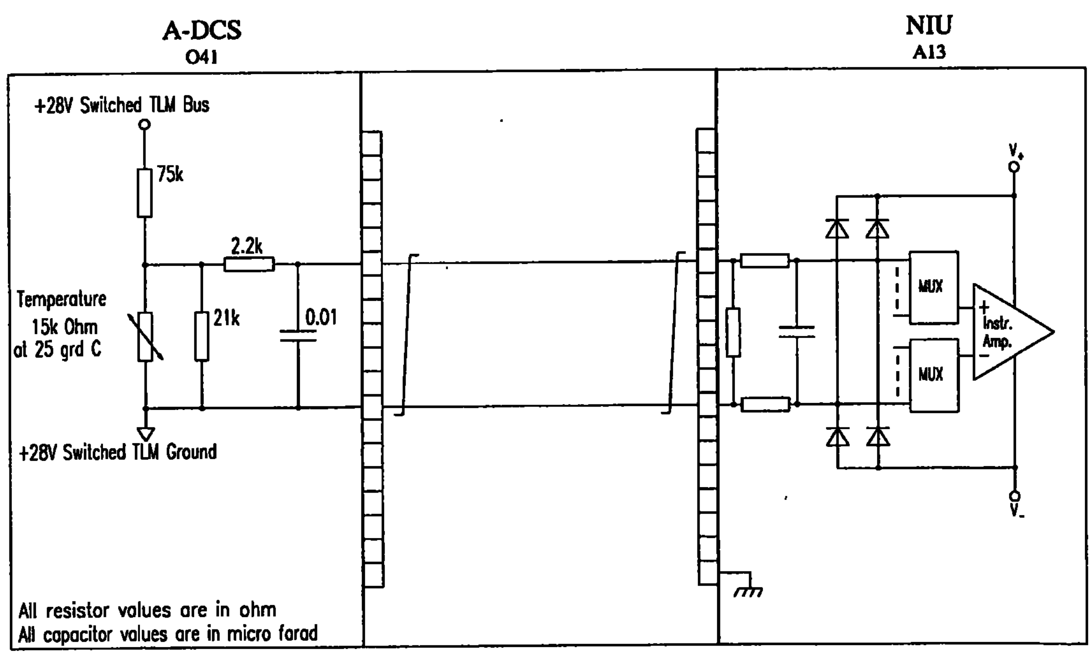
Only one Signal Ground line is provided from A-DCS for all analog TLM interfaces

Fig. 3.5.2.1.2-6 : A-DCS +12V, +5V and IDC Analog Telemetry Interface Circuit



Only one Signal Ground line is provided from A-DCS for all analog TLM interfaces

Fig. 3.5.2.1.2-7 : A-DCS Analog Telemetry Interface Circuit (Other Voltages)



Only one Switched TLM Ground line is provided from A-DCS for all temperature (Sw. TLM bus) interfaces

Fig. 3.5.2.1.2-8 : A-DCS Temperature Telemetry (Switched TLM Bus) Interface Circuit

A-DCS (Digital Data A)
NIU (Data Enable)
O11

NIU (Digital Data A)
A-DCS (Data Enable)
B11

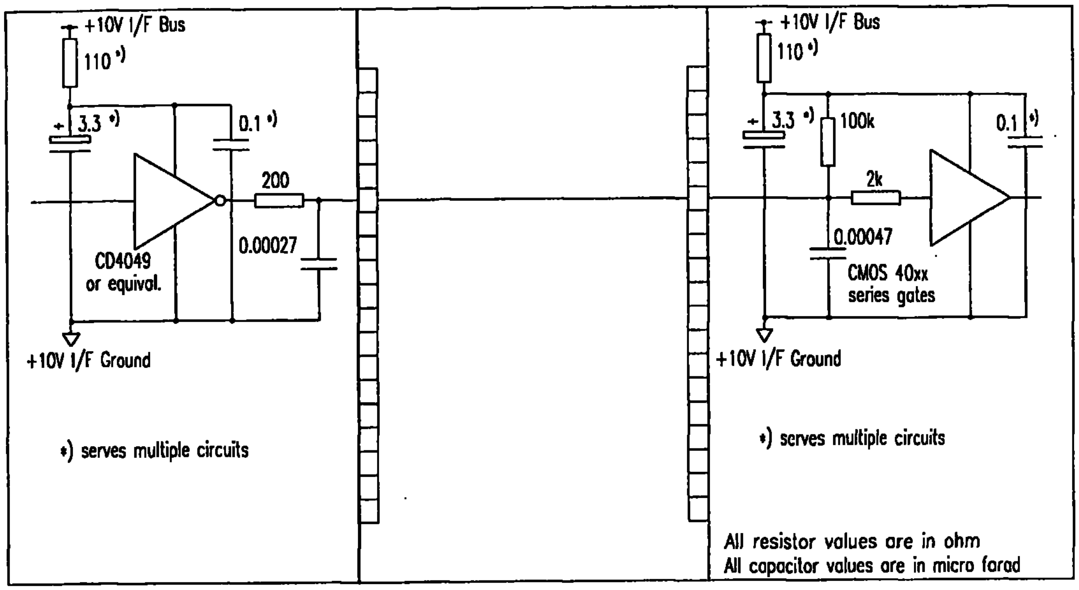


Fig. 3.5.2.1.2-9 : Digital Data A / Data Enable Interface Circuit

NIU
O11

A-DCS
B28

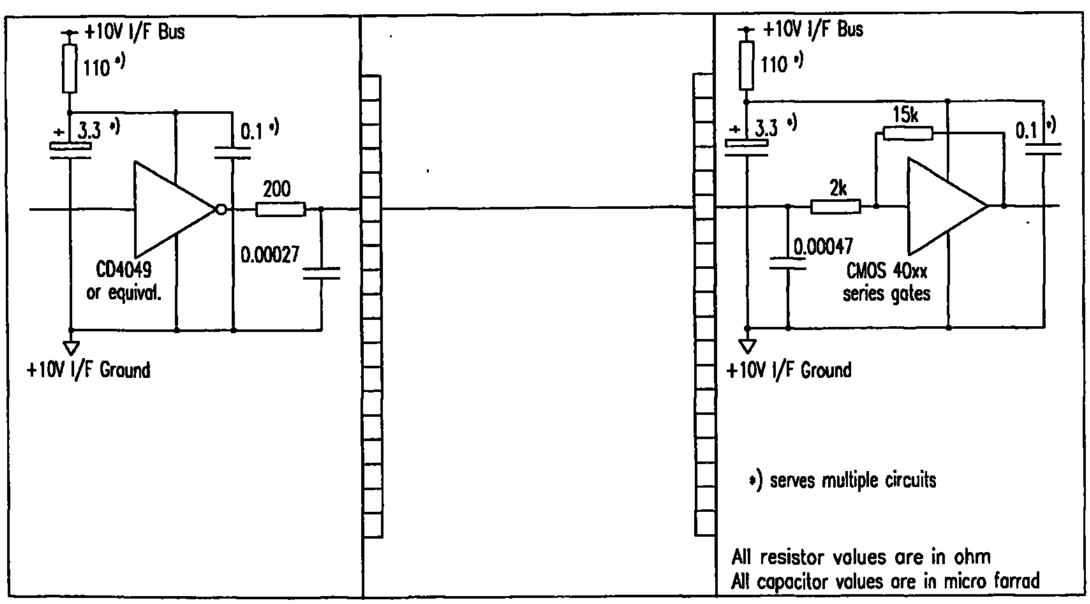


Fig. 3.5.2.1.2-10 : A-DCS 8.32 kHz Clock Interface Circuit

3.5.2.2. Signal Connectors (Interfaces With PLM Units)

Table 3.5.2.2-1 identifies the Signal connector types at the A-DCS boxes and Table 3.5.2.2-2 identifies the signal connector types at the A-DCS harness.

Connector	Connector-Type	Function
J209	DCMA-37P	Commands
J210	DDMA-50S	Telemetry

Table 3.5.2.2-1 : Signal Connector Types at A-DCS (RPU) Boxes for Interfaces With PLM

Connector	Connector-Type	Function
P209	DCMA-37S-NMB	Commands
P210	DDMA-50P-NMB	Telemetry

Table 3.5.2.2-2 : Signal Connector Types at A-DCS (RPU) Harness for Interfaces With PLM

3.5.2.3. Signal Pin Allocation Lists (Interfaces With PLM Units)

In these lists, the cross reference between connector pin, signal designation, Interface Data Sheet, target connector and target connector pin is defined. Per connector one list is prepared.

Interface Data Sheets can be found in § 3.5.2.1.1

The individual pin allocation lists are specified by 10 characters of a alpha numerical connector number. For the A-DCS the first 5 characters are NADCS. Character 6 is reserved. The 7th character is J for a box connector or P for a harness connector. The last three characters define the connector number.

Since these lists also specify wiring and shielding, they will form the basis for harness manufacturing.

The signal connector pin allocations at instrument level are described in AD8. The signal connector harness are described in Tables 3.5.2.3/3 and /4.

Connector : NADCS- P209 Item : A-DCS Function : Command Conn.-Type : DCMA-37S-NMB
EMC-Category : 2 Location : 2F

			Interface-Code			Grouping									
Pin	Signal Designation		Circ	Signal	Pos.	Ch. ID	Wiring	Shd	Cable	Twist	Comment	End-It.	Loc.	Connector	Pin
01	TC_RX1_Select_DCS	SIG	B10	CCP.-	D	CC01	SL-24		A			NIU	2D	PNIU-- P15	002
02	TC_RX2_Select_DCS	SIG	B10	CCP.-	D	CC02	SL-24		A			NIU	2D	PNIU-- P15	003
03	TC_RX1_On_DCS	SIG	B10	CCP.-	D	CC03	SL-24		A			NIU	2D	PNIU-- P15	004
04	TC_RX1_Off_DCS	SIG	B10	CCP.-	D	CC04	SL-24		A			NIU	2D	PNIU-- P15	005
05	TC_RX2_On_DCS	SIG	B10	CCP.-	D	CC05	SL-24		A			NIU	2D	PNIU-- P15	006
06	TC_RX2_Off_DCS	SIG	B10	CCP.-	D	CC06	SL-24		A			NIU	2D	PNIU-- P15	007
07	TC_DCS_Restart	SIG	B10	CCP.-	D	CC07	SL-24		A			NIU	2D	PNIU-- P15	014
32	TC_Lvl_Cmd5_DCS	SIG	B10	CCP.-	D	CC15	SL-24		A			NIU	2D	PNIU-- P15	022
08	TC_Upload_Author_DCS	SIG	B10	CCP.-	D	CC08	SL-24		A			NIU	2D	PNIU-- P15	015
14	TC_Lvl_Cmd6_DCS	SIG	B10	CCP.-	D	CC16	SL-24		A			NIU	2D	PNIU-- P15	023
09	TC_Strb_Lvl_Cmd_DCS	SIG	B10	CCP.-	D	CC09	SL-24		A			NIU	2D	PNIU-- P15	016
20	TC_TX1_Select_DCS	SIG	B10	CCP.-	D	CC17	SL-24		A			NIU	2D	PNIU-- P15	008
11	TC_Lvl_Cmd0_DCS	SIG	B10	CCP.-	D	CC10	SL-24		A			NIU	2D	PNIU-- P15	017
21	TC_TX2_Select_DCS	SIG	B10	CCP.-	D	CC18	SL-24		A			NIU	2D	PNIU-- P15	009
30	TC_Lvl_Cmd1_DCS	SIG	B10	CCP.-	D	CC11	SL-24		A			NIU	2D	PNIU-- P15	018
22	TC_TX1_On_DCS	SIG	B10	CCP.-	D	CC19	SL-24		A			NIU	2D	PNIU-- P15	010
12	TC_Lvl_Cmd2_DCS	SIG	B10	CCP.-	D	CC12	SL-24		A			NIU	2D	PNIU-- P15	019
23	TC_TX1_Off_DCS	SIG	B10	CCP.-	D	CC20	SL-24		A			NIU	2D	PNIU-- P15	011
31	TC_Lvl_Cmd3_DCS	SIG	B10	CCP.-	D	CC13	SL-24		A			NIU	2D	PNIU-- P15	020
24	TC_TX2_On_DCS	SIG	B10	CCP.-	D	CC21	SL-24		A			NIU	2D	PNIU-- P15	012
13	TC_Lvl_Cmd4_DCS	SIG	B10	CCP.-	D	CC14	SL-24		A			NIU	2D	PNIU-- P15	021
25	TC_TX2_Off_DCS	SIG	B10	CCP.-	D	CC22	SL-24		A			NIU	2D	PNIU-- P15	013
16	+10V I/F Bus DCS	SUP		DPB.1		DP99	TP-20		A			NIU	2D	PNIU-- P15	035
35	+10V I/F Bus DCS	RTN		DPB.1		DP99	TP-20		A			NIU	2D	PNIU-- P15	034
17	Bridge to pin 16	-							A						
36	Bridge to pin 35	-							A						
BS	CABLE SHIELD	-	SHD						A			NIU	2D	PNIU-- P15	BS
10	NC														
15	NC														
18	NC														
19	NC														
26	NC														
27	NC														
28	NC														
29	NC														
37	NC														
33	Signal GND														
34	Signal GND														
BS	OVERALL SHD											NIU	2D	PNIU-- P15	BS

Table 3.5.2.3/3 : Pin Allocation List of Connector P209 (For Information Only)

Connector : NADCS- P210 Item : A-DCS Function : Telemetry Conn.-Type : DDMA-50P-NMB
EMC-Category : 2 Location : 2F

Pin	Signal Designation		Interface-Code Circ	Interface-Code Signal	Interface-Code Pos.	Ch. ID	Grouping Wiring	Grouping Shd	Cable	Twist	Comment	End-It.	Loc.	Connector	Pin
01	TM_StatRX_PwrSel_DCS	SIG	O39	TLD.-	D	TL01	SL-24		A			NIU	2D	PNIU-- P15	036
18	TM_StatRX_AntSel_DCS	SIG	O37	TLD.-	D	TL02	SL-24		A			NIU	2D	PNIU-- P15	037
02	TM_StatRX1_OnOff_DCS	SIG	O41	TLD.-	D	TL03	SL-24		A			NIU	2D	PNIU-- P15	038
19	TM_StatRX2_OnOff_DCS	SIG	O42	TLD.-	D	TL04	SL-24		A			NIU	2D	PNIU-- P15	039
34	TM_StatTX_PwrSel_DCS	SIG	O35	TLD.-	D	TL05	SL-24		A			NIU	2D	PNIU-- P15	040
35	TM_StatTX_AntSel_DCS	SIG	O35	TLD.-	D	TL06	SL-24		A			NIU	2D	PNIU-- P15	041
36	TM_StatTX1_OnOff_DCS	SIG	O35	TLD.-	D	TL07	SL-24		A			NIU	2D	PNIU-- P15	042
37	TM_StatTX2_OnOff_DCS	SIG	O35	TLD.-	D	TL08	SL-24		A			NIU	2D	PNIU-- P15	043
04	TM_Stat_DCS_D0	SIG	O36	TLD.-	D	TL09	SL-24		A			NIU	2D	PNIU-- P15	044
21	TM_Stat_DCS_D1	SIG	O38	TLD.-	D	TL10	SL-24		A			NIU	2D	PNIU-- P15	045
38	TM_Stat_DCS_D2	SIG	O40	TLD.-	D	TL11	SL-24		A			NIU	2D	PNIU-- P15	046
05	TM_Stat_DCS_D3	SIG	O43	TLD.-	D	TL12	SL-24		A			NIU	2D	PNIU-- P15	047
22	TM_Stat_DCS_D4	SIG	O41	TLD.-	D	TL13	SL-24		A			NIU	2D	PNIU-- P15	048
39	TM_Stat_DCS_D5	SIG	O35	TLD.-	D	TL14	SL-24		A			NIU	2D	PNIU-- P15	049
06	TM_Stat_DCS_D6	SIG	O35	TLD.-	D	TL15	SL-24		A			NIU	2D	PNIU-- P15	050
23	TM_Stat_DCS_D7	SIG	O35	TLD.-	D	TL16	SL-24		A			NIU	2D	PNIU-- P15	051
BS	CABLE SHIELD	-	SHD						A			NIU	2D	PNIU-- P15	BS
11	TM_Volt_RPU_5Vp_DCS	SIG	O35	TLA.-	D	TL21	SL-24		B			NIU	2D	PNIU-- P15	056
28	TM_Volt_RPU_5Vm_DCS	SIG	O35	TLA.-	D	TL22	SL-24		B			NIU	2D	PNIU-- P15	057
12	TM_Volt_RPU_12Vp_DCS	SIG	O35	TLA.-	D	TL23	SL-24		B			NIU	2D	PNIU-- P15	058
29	TM_Volt_RPU_12Vm_DCS	SIG	O41	TLA.-	D	TL24	SL-24		B			NIU	2D	PNIU-- P15	059
44	TM_Volt_TXU_5Vp_DCS	SIG	O41	TLA.-	D	TL25	SL-24		B			NIU	2D	PNIU-- P15	060
45	TM_Volt_TXU_5Vm_DCS	SIG	O36	TLA.-	D	TL26	SL-24		B			NIU	2D	PNIU-- P15	061
46	TM_Volt_TXU_12Vp_DCS	SIG		TLA.-		TL27	SL-24		B			NIU	2D	PNIU-- P15	062
47	TM_Volt_TXU_12Vm_DCS	SIG		TLA.-		TL28	SL-24		B			NIU	2D	PNIU-- P15	063
13	TM_Volt_OCXO_D0_DCS	SIG		TLA.-		TL29	SL-24		B			NIU	2D	PNIU-- P15	064
14	TM_Volt_OCXO_D1_DCS	SIG		TLA.-		TL60	SL-24		B			NIU	2D	PNIU-- P15	065
30	TM_Volt_TX_D0_DCS	SIG		TLA.-		TL61	SL-24		B			NIU	2D	PNIU-- P15	066
31	TM_Volt_TX_D1_DCS	SIG		TLA.-		TL62	SL-24		B			NIU	2D	PNIU-- P15	067
15	TM_Volt_DCS_D0	SIG		TLA.-		TL63	SL-24		B			NIU	2D	PNIU-- P15	073
16	TM_Volt_DCS_D1	SIG		TLA.-		TL64	SL-24		B			NIU	2D	PNIU-- P15	074

Table 3.5.2.3/4 : Pin Allocation List of Connector P210 (1/2 - For Information Only)

Pin	Signal Designation		Interface-Code Circ	Interface-Code Signal	Interface-Code Pos.	Ch. ID	Grouping Wiring	Grouping Shd	Cable	Twist	Comment	End-It.	Loc.	Connector	Pin
08	TM_Tmp_RPU_DCS	SIG		TLA.-		TL65	SL-24		B			NIU	2D	PNIU-- P15	078
25	TM_Tmp_RPU_Pwr_DCS	SIG		TLA.-		TL66	SL-24		B			NIU	2D	PNIU-- P15	079
41	TM_Tmp_TXU_DCS	SIG		TLA.-		TL67	SL-24		B			NIU	2D	PNIU-- P15	080
42	TM_Tmp_TXU_Pwr_DCS	SIG		TLA.-		TL68	SL-24		B			NIU	2D	PNIU-- P15	081
09	TM_Tmp_Spare0_DCS	SIG		TLA.-		TL69	SL-24		B			NIU	2D	PNIU-- P15	082
26	TM_Tmp_Spare1_DCS	SIG		TLA.-		TL70	SL-24		B			NIU	2D	PNIU-- P15	083
03	Signal Ground DCS	GND		GND.-		GD22	SL-20		B			NIU	2D	PNIU-- P15	085
20	Bridge to pin 03	-							B						
07	SWTM Ground DCS	GND		GND.T		GD21	SL-24		B			NIU	2D	PNIU-- P15	086
24	Bridge to pin 07	-							B						
BS	CABLE SHIELD	SHD	SHD						B			NIU	2D	PNIU-- P15	BS
32	Data Enable DCS	B11	B11	DEN.-	D	DE01	SL-24		C			NIU	2D	PNIU-- P26	09
49	Data Output DCS	B11	B11	DOA.-	D	DO01	SL-24		C			NIU	2D	PNIU-- P26	28
48	8.32KHz Clock DCS	B28	B28	CLU.-	D	CU10	SL-24		C			NIU	2D	PNIU-- P26	10
17	NC								C		32s Frame removed				
BS	CABLE SHIELD	SHD	SHD						C			NIU	2D	PNIU-- P26	BS
10	NC														
27	NC														
33	NC														
40	NC														
50	NC														
43	NC														
BS	OVERALL SHIELD											NIU	2D	PNIU-- P15	BS

Table 3.5.2.3/4 : Pin Allocation List of Connector P210 (2/2 - For Information Only)

3.5.3. Signal Interfaces With RFF and DTA

3.5.3.1. Signal Interface Requirements (Interfaces With RFF and DTA)

There is no signal interface requirement between METOP and A-DCS for the RF signals from and to A-DCS : interface data sheets and interface circuits are N/A (see RD2).

3.5.3.2. Signal Connectors (Interfaces With RFF and DTA)

Table 3.5.3.2-1 identifies the unit mounted RF connector types on the signal path RPU - RFF (Accommodation Hardware) and TXU - DTA and Table 3.5.3.2-2 at the relevant harness.

Connector	Connector-Type	Function
J205	R 126414 (SMA female)	RF signal from CRA / RFF (Accommodation Hardware)
J305	R 126414 (SMA female)	RF signal to DTA

Table 3.5.3.2-1 : Unit Mounted RF Connector Types on the Signal Path RPU/RFF and TXU/DTA

Connector	Connector-Type	Function
P205	SMA male TBD_{MET}	RF signal from CRA / RFF
P305	SMA male TBD_{MET}	RF signal to RFF / DTA

Table 3.5.3.2-2 : Harness Mounted RF Connector on the Signal Path RPU / RFF and TXU / DTA

3.5.3.3. Pin Allocation List (Interfaces With RFF and DTA)

In these lists, the cross reference between connector pin, signal designation, Interface Data Sheet, target connector and target connector pin is defined and recorded as data base. Per connector one list is prepared.

Interface Data Sheets can be found in § 3.5.3.1.1

The individual pin allocation lists are specified by 10 characters of a alpha numerical connector number. For the RPU, the first 6 characters are NADCSR, and for the TXU, the first 6 characters are NADCST. The 7th character is J for a box connector or P for a harness connector. The last two /three characters define the connector number.

Since these lists also specify wiring and shielding, they will form the basis for harness manufacturing.

The connectors pin allocations are shown in AD8. The signal connector harness is shown in Tables 3.5.3.3-1 and -2.

Connector : NADCS- P205 | **Item : A-DCS** | **EMC-Category : F** | **Function :** RX Antenna | **Location :** 2F | **Conn.-Type : 3402-001-16-000**

			Interface-Code					Grouping							
Pin	**Signal Designation**		**Circ**	**Signal**	**Pos.**	**Ch. ID**	**Wiring**	**Shd**	**Cable**	**Twist**	**Comment**	**End-It.**	**Loc.**	**Connector**	**Pin**
01	401.635MHz A-DCS	SIG		RFL.-		RFL6	COAX-26	1				UHF PwrSpl	1F	NCRPS-P02	01
BS	CABLE SHIELD	-	SHD					1				UHF PwrSpl	1F	NCRPS-P02	BS

Table 3.5.3.3-1 : Pin Allocation List of Connector P205

(For Information Only)

Connector : NADCST P305 | **Item : A-DCS** | **EMC-Category : F** | **Function :** TX Antenna | **Location :** 2F | **Conn.-Type : 3402-001-16-000**

			Interface-Code					Grouping							
Pin	**Signal Designation**		**Circ**	**Signal**	**Pos.**	**Ch. ID**	**Wiring**	**Shd**	**Cable**	**Twist**	**Comment**	**End-It.**	**Loc.**	**Connector**	**Pin**
01	466MHz A-DCS	SIG		RFL.-		RFL6	COAX-26	1				DTA	2G	NCRDTA-P02	01
BS	CABLE SHIELD	-	SHD					1				DTA	2G	NCRDTA-P02	BS

Table 3.5.3.3-2 : Pin Allocation List of Connector P205

(For Information Only)

3.5.4. Interfaces Between ADCS Units

3.5.4.1. Interface Data Sheet and Interface Circuit

Not applicable : this is an internal ADCS interface.

3.5.4.2. Connectors

Table 3.5.4.2-1 identifies the A-DCS internal connector types at the RPU / TXU boxes. Description at harness level is as described in AD8.

RPU		TXU		Function
Connector	Connector-Type	Connector	Connector-Type	
J216	DAMA 15S NMB	J308	DAMA 15P NMB	TXU Power
J217	DCMA 37S NMB	J309	DCMA 37P NMB	TXU Commands
J218	DBMA 25P NMB	J310	DBMA 25S NMB	TXU Telemetry
J219	SMA (female) R125 415	J301	SMA (female) R125 403	REF1
J220	SMA (female) R125 415	J302	SMA (female) R125 403	REF2
J221	SMA (female) R125 415	J303	SMA (female) R125 403	MOD1
J222	SMA (female) R125 415	J304	SMA (female) R125 403	MOD2

Table 3.5.4.2-1 : RPU / TXU Connector Types at Boxes

3.6. TEST INTERFACES

J206 and J207 are test connectors to be used by the Instrument Supplier only. They are not used at system level. Flight covers are delivered for these connectors.

Test connector SHD J223 shall be used at system level. Its use is for ground testing only (EMC). It shall connected to outside EGSE equipments (DAC and Dual Channel Dynamic Analyzer, see § 5.6.1.3.).

3.7. HARNESS

The harness between METOP units and the A-DCS is under the responsibility of the PLM, based on the connector & pin lay-out definition and electrical performances from § 3.4 and 3.5.2.

The harness between the RF equipment and the A-DCS is under the responsibility of the Accommodation Hardware supplier based on the harness routing provided by the PLM.

The harness between the A-DCS units is under the responsibility of the Accommodation Hardware supplier, based on the connector & pin lay-out definition and electrical performances from § 3.5.4., the harness routing provided by the PLM (the harness max length is defined for reference in § 2.2.1.) and the EMC design rules from § 3.8.1.6. and 3.8.1.7.

3.8. EMC INTERFACE DESCRIPTION

3.8.1. Electrical Bonding

3.8.1.1. General

Bonding is the method by which adjacent conductive elements are electrically connected in order to minimize any potential differences and flow of electrical currents.

To prevent corrosion and alloying, bonding of dissimilar materials shall be avoided (same group in the electromechanical series). If bonding of dissimilar metals cannot be avoided, the relative areas of the anode and cathode are important and finishing shall be applied around both materials.

The bond itself shall be resistant against corrosion and shall have an adequate cross section to carry fault currents of 7.5 A for an indefinite time.

All bonding resistance values shall apply for both directions of polarization across the bond. All bonding resistance values shall be achieved without the contribution of cable shields and surface to surface contact of moveable structural parts.

3.8.1.2. Joint Faces

Joint faces shall be clean and flat before assembly. The only permitted surface finishes are :
- clean metal, except magnesium
- gold plate on the base metal
- alodine 1200 or similar according to MIL-C-5541

Any other anti-corrosion finish (anodizing) shall be removed from joint faces before bonding.

3.8.1.3. Structural Parts

Conductive structure parts shall be electrically bonded to each other either by direct metal-to-metal contact conductive gaskets or finishes or by use of metal bond straps.

3.8.1.3.1. DC Resistance between Mating Metal Structure Parts

The DC resistance between two mating metal structure parts shall be ≤ 2.5 mΩ. The minimum size of the contact area shall be 1 cm².

3.8.1.3.2. Bonding of Movable Parts

N/A.

3.8.1.3.3. Bonding of Structural CFRP Parts

N/A.

3.8.1.3.4. Bonding of Carbon Fibre Face Sheets

N/A.

3.8.1.3.5. Bonding of Aluminium Honeycomb

Aluminium honeycomb shall be bonded to structure by a DC resistance of ≤ 10 Ω.

3.8.1.3.6. Bonding of Metal Fittings

N/A.

3.8.1.4. Unit Housings

3.8.1.4.1. Bonding of Unit Cases

All unit cases shall be bonded to spacecraft structure via the equipment box feet. The minimum bonding contact area shall be at least 1 cm^2. The resistance between unit case and clean aluminium structure shall be ≤ 10 mΩ.

3.8.1.4.2. Bonding of Thermally Isolated Boxes

N/A.

3.8.1.4.3. Bonding of Unit mounted on CFRP or Non-conductive Parts

N/A.

3.8.1.4.4. DC Resistance between Adjacent Unit Case Parts

For each particular box case all conductive parts shall be bonded to each other either by direct (metal-to-metal) or indirect bonding (via conductive jumper). The resistance between unit case parts shall be measured to ensure that the shielding behaviour of the unit housing is not changed between the various flight models.

3.8.1.4.5. DC Resistance between Bonding Stud and Mounting Feet

N/A.

3.8.1.5. Thermal Blankets

N/A.

3.8.1.6. Cable and Harness Shields

3.8.1.6.1. Grounding of Cable Shields

Cable shields shall be grounded at both ends and shall be grounded at all intermediate interfaces on both sides of that interface.

DC Resistance between Cable Shields and Shield Ground Point

The DC resistance between the single cable shield and its shield ground point (at the connector, unit case, or intermediate points) shall be $\leq 10\ m\Omega$.

DC Resistance between Connector Shield Ground Pin and the Case

The DC resistance between the connector shield ground pin and the equipment chassis shall not exceed 10 mΩ.

3.8.1.6.2. Bonding of Overall Harness Shields

Overall harness shields shall be terminated to the equipment case respectively connector brackets by the connector back shell or dedicated bond straps. The overall harness shield shall be grounded to structure at intermediate points (approx. every 20 cm) where the harness is mechanically fixed to the structure.

DC Resistance between Connector Back Shell and Overall Harness Shield

The DC resistance between connector back shell and overall harness shield shall be $\leq 100\ m\Omega$.

DC Resistance between Overall Harness Shield and Structure

The DC resistance between the harness shield and structure via the tie-base shall not exceed 1 Ω.

3.8.1.7. Connectors

3.8.1.7.1. Design of Connectors

All connectors shall include a metallic outer shell such that the connector including cabling is completely shielded as soon as the mating connector is inserted in the box mounted part.

3.8.1.7.2. Bonding Resistance of Connector Receptacle

The connector receptacle shall be bonded to the equipment case with a DC resistance of $\leq 10\ m\Omega$.

3.8.1.7.3. Bonding Resistance of Connector Back Shell

The connector back shell as part of the cable shield shall exhibit a DC resistance of $\leq 10\ m\Omega$ (via connector receptacle) to equipment case when connected.

3.8.2. Grounding and Isolation

The grounding system of the instrument shall use separate grounds (see Figure 3.8.2-1) as follows :

- +28 V Main Power Ground
- +28 V Switched TLM Bus
- +10 V Interface Ground
- Signal Ground

Each ground shall be electrically isolated from all other grounds within the instrument and from chassis by 100 kΩ or greater DC resistance in parallel with a stray capacitance of ≤ 50 nF.

Between the signal ground an the +28 V main power ground the isolation requirement shall be 1 MΩ in parallel with a stray capacitance of ≤ 50 nF.

These minimum values (100 kΩ and 1 MΩ) are the specifications for measurements performed with an ohmmeter using 100 mV, or less, between grounds.

WARNING : in case a voltage greater than 100 mV is used, this voltage shall be less than 10 V, for the safety of the flight model.

3.8.2.1. +28 V Main Power Ground

The +28V main power return is grounded within the PCU to structure .

3.8.2.2. +28 V Switched Telemetry Ground

The +28 V switched telemetry return is grounded within the PCU to structure.

3.8.2.3. +10 V Interface Ground

The +10 V interface return is grounded within the NIU to structure.

3.8.2.4. Signal Ground

Signal ground is the power return line for the secondary side of the instrument DC/DC converters. The signal ground is grounded within the A-DCS to structure in the receiver (RPU) and in the transmitter (TXU) (see Figure 3.8.2-1).

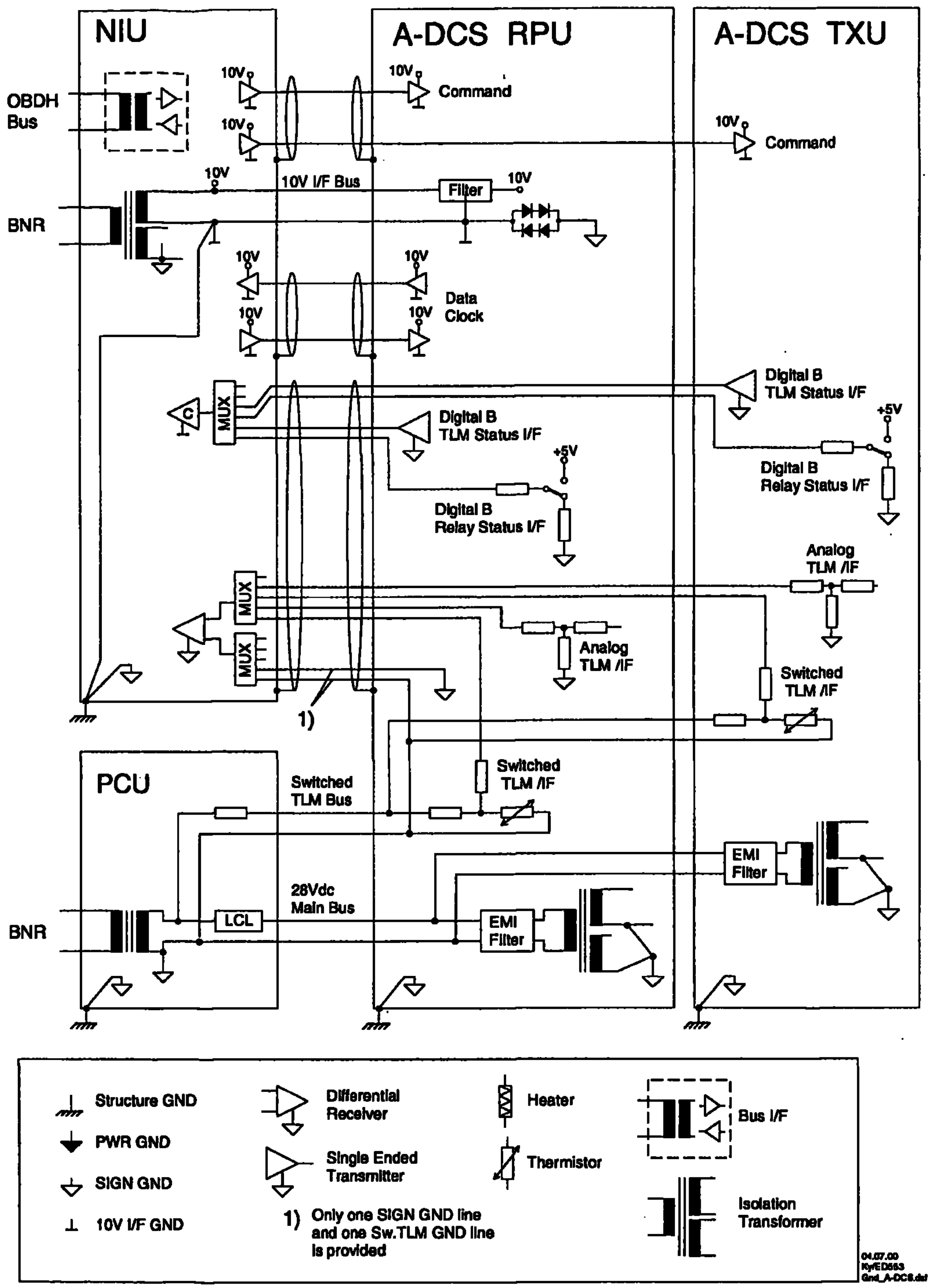


Figure 3.8.2-1 : Grounding and Isolation Concept for A-DCS

3.8.3. Shielding

3.8.3.1. Wire Shielding

3.8.3.1.1. Bonding of Shields

Wire shield shall be bonded to the connector body and shall not be routed through the connector to the inside of the equipment.

When multiple shielding is used, each shield shall be grounded separately.

3.8.3.1.2 Overall Shield

Overall shields shall be terminated by the connector back shell. The overall harness shield shall be made of an aluminium-foil double wrapped with at least 50 % overlapping. The tape shall have a minimum thickness of 0.03 mm and a preferred width of 25 mm.

3.8.3.1.3 Shields as Current-Carrying Conductors

Shields shall not be used as intentional current-carrying conductors and not as return lines for power and signal with exception of the RF coaxial lines.

3.8.3.2. Case Shielding

3.8.3.2.1. Non-magnetic Metallic Housing

Each equipment housing shall be manufactured from a non- magnetic material, which shall form an all-enclosing electromagnetic shield.

3.8.3.2.2. Case Apertures

The case shall not contain any apertures other than those essential for connectors, sensor viewing or outgassing vents.

3.8.3.2.3. Venting Holes

If outgassing vents are required, they shall be as small as possible (less than 5 mm diameter) and shall be located close to the unit mechanical mounting plane, i.e. spacecraft structure ground. Venting holes shall provide electromagnetic shielding performance of ≥ 40 dB up to 18 GHz.

3.8.4. A-DCS Frequency Characteristics

The A-DCS RF input and output characteristics are given in § 1.2.2 and § 3.9.

The internal frequencies are :

Source	Frequency	User
TBD_{ADCS}	TBD_{ADCS}	TBD_{ADCS}

3.8.5. Magnetic Moment

The maximum magnetic moment of the instrument shall not exceed 500 mAm² (TBC_{MET}). The magnetic moment correspond to a magnetic field of 100 nT at 1 m distance (1 Gauss equals to 10^{-4} T).

List of Magnetic Material

Magnetic materials used in the instrument are listed in Table 3.8.5.-1

Material	Standard	Magnetic Characteristic	Remark
name of material	*AISI etc.*	*soft / hard*	
TBD_{ADCS}	TBD_{ADCS}	TBD_{ADCS}	

Table 3.8.5.-1 : Magnetic Materials Used in the Instrument

3.8.6. EMC Performance Requirements

The EMC performances for the A-DCS are dealt within § 4.3.

3.9. RF INTERFACE DESCRIPTION

The A-DCS requires one RF input at 401.635 MHz and one RF output at 465.9875 MHz.

3.9.1. Receive Function Characteristics

3.9.1.1. Receiver Electrical Characteristics

The A-DCS receiver functional block diagram is illustrated in Figure 3.9.1.1.1/1.

The electrical characteristics of the A-DCS receiver are illustrated in Figure 3.9.1.1/1.

#	Parameter	Unit	Values for 401.635 MHz Receiver
a	1 dB Bandwidth	kHz	± 55 kHz
b	Receiver Noise Temp.	deg. K	< 300
c	Antenna Polarization	N/A	RHCP
d	Dynamic Range	dBW	- 167 to - 135
e	Linearity	N/A	2 signals at -132 dBW shall not generate a third order IMP with a power higher than -177 dBW.
f	Image Rejection (for information only)	dB	> 125 dB
g	Frequency Stability (for information only)	N/A	1.E-10 over 1 day
i	Nominal Receiver RF Load Impedance (Unit RF Port)	Ω	50
j	Receiver VSWR	N/A	< 1.4
k	Maximum Input Level	dBm	-15 (Note 1)

Note 1 : The maximum input level is given at the level of the ADCS Instrument input port, i.e. connector J20.05.

Figure 3.9.1.1/1 : A-DCS Receiver Electrical Characteristics

TBD_{ADCS}

Figure 3.9.1.1.1/1. : A-DCS Receiver and Transmitter Functional Block Diagram

3.9.1.2. Receiver RF Characteristics

Each receiver can be characterized by a template which defines its capability to withstand CW or broad band noise-like interfering signals with a known degradation performance.

The receiver susceptibility data for the A-DCS are defined in Figure 3.9.1.2/1.

When illuminated by a single coherent line with a power level defined by the A-DCS template, the probability of the A-DCS receiver PLL locking on the spurious line shall be 0.

When exposed to the noise levels defined on the template, the A-DCS uplink BER shall not be degraded by a factor greater than 2.

Max Signal Level at A-DCS RF Receiver Terminal			
Frequency (MHz)	**Maximum Narrow Signal Level (dBm)**	**Maximum Wide Signal Density (dBm/Hz) (3)**	
0 - 15	-5 (1)	-38	
15 - 375	-25 (1)	-58	
375 - 385	-65 (1)	-98	
385 - 396	-100 (1)	-138	
396 - 401.5	-125 (1)	-163	
401.5 - 401.6	-145 (2)	-183	
401.6 - 401.7	-147 (2)	-183	
401.7 - 401.8	-145 (2)	-183	
401.8 - 406	-125 (1)	-163	
406 - 411	-100 (1)	-138	
411 - 425	-65 (1)	-98	
425 - 1000	-25 (1)	-58	
1000 - 10000	-25 (1)	-58	
10000 - 200000	-25 (1)	-58	

Notes (1) and (2) are applicable to maximum narrow band signal levels.

(1) Measured in "narrow band" defined in MIL STD 461C/462 EMC requirements

(2) Measured in a "100 Hz" bandwidth using a low noise preamplifier and a spectrum analyzer. This specification is for narrow band interferer.

(3) Applicable to the additive noise picked-up by the Accommodation Hardware.

Note : METOP assumes that the A-DCS receivers are compatible with any emission from ground.

Figure 3.9.1.2/1 : A-DCS Receiver Susceptibility (A-DCS Template)

3.9.1.3. Radiated Emission at Central Frequency

The emitted power by the receiver through the antenna connector, at the central frequency of the receiver band at 401.635 MHz shall be less than –135 dBm.

3.9.2. Transmitting Function Characteristics

3.9.2.1. Transmitter Electrical Characteristics

The electrical characteristics of the A-DCS transmitter are the following :

Parameter	Unit	Value
Centre Frequency	MHz	465.9875
Frequency Stability	N/A	10^{-5}
Modulation Index	rad. (RMS)	0.8 ± 10 %
Data Rate	bps	200 or 400
Nominal Power Output of Transmitter	W	5.0 TBC_{ADCS}
Bandwidth	kHz	3
Modulation Type	N/A	PCM Bi-phase-L / PM
Nominal Transmitter RF Load Impedance (Unit RF Port)	Ω	50
Transmitter VSWR	N/A	< TBD_{ADCS}

3.9.2.2. Transmitter RF Characteristics

3.9.2.2.1. Discrete Spurious Emission Limits

Discrete spurious emission shall not exceed the limits of the following table. CF is the carrier frequency.

Frequency Range Above and Below Carrier Frequency (MHz)	Power Level (for any 1 MHz bandwidth) (dBm)
Up to 1 MHz (CF ± 1 MHz)	37
1 MHz - 30 MHz	-23
Above 30 MHz	-53

3.9.2.2.2. Noise-Like Spurious Emission Limits

The noise-like spurious levels shall not exceed the limits of the following table. CF is the carrier frequency.

Frequency Range Above and Below Carrier Frequency (MHz)	Power Level (dBW/Hz)
Up to 30 MHz (CF ± 30 MHz)	TBD_{ADCS}
Above 30 MHz	-153

3.9.2.2.3. Specific Out-of-Band Emission Levels

Frequency Bands (MHz)	Requirement at ADCS Transmitter Output (dBm)	Receiver Affected by Spurious Signals	Notes
114 - 118	-49	SARR 121 MHz	1
118 - 120	-88		1
120 - 121.45	-113		2
121.45 - 121.55	-169		5
121.45 - 121.55	-133		2
121.55 - 123	-113		2
123 - 125	-88		1
125 - 129	-49		1
228 - 236	-48	SARR 243 MHz	1
236 - 240	-86		1
240 - 242.925	-111		2
242.925 - 243.075	-167		5
242.925 - 243.075	-131		2
243.075 - 246	-111		2
246 - 250	-86		1
250 - 258	-48		1
375 - 385	-42	SARR 406.05 MHz	1
385 - 396	-77		1
396 - 411	-102		1
401.5 - 401.8	-160		5
401.5 - 401.8	-124		2
405.9 - 406.2	-160		5
405.9 - 406.2	-124		2
411 - 425	-77		1
425 - 435	-42		1
1207 - 1267	-90	GRAS	3
1555 - 1624	-88		3
2043.0 - 2051.9	-34	S-Band	4
2051.9 - 2055.0	-102		4
2055.0 - 2063.0	-34		4
5253 - 5256	-98	ASCAT	4
5253 - 5256	-151		5

Notes :

1) Measured in a narrow band defined in MIL STD 461C/462 EMC requirements.
2) Measured with a 100 Hz bandwidth
3) Integrated power over any 500 kHz band
4) Discrete spurious, only one allowed in the frequency band.
5) Broad band noise (in dBm/Hz) TBC_{MET}

Table 3.9.2.2-1 : A-DCS Transmitter Out-of-Band Characteristics

4. INSTRUMENT VERIFICATION DESCRIPTION

This section specifies the instrument level verification requirements.

All items to be flown on the satellite have to be qualified. An item that has been already qualified needs only acceptance testing when qualified to levels same as or greater than specified for METOP. If qualification by similarity is claimed, this has to be justified by analysis and documented with previous achieved qualification reports.

4.1. MECHANICAL / STRUCTURAL VERIFICATION

4.1.1. Structural Analysis

4.1.1.1. Quasi-Static Loads

A stress analysis shall demonstrate that the instrument interface structure design is compatible with the METOP design loads, based on the flight limit loads from § 2.2.8.

4.1.1.2. Structural / Dynamic Analyses

In those areas where verification by test cannot or has not been performed, a verification by analysis is required in following areas :

- Stress analysis of instrument critical parts.
- Instrument structural analyses, for frequency mode definition.

4.1.1.3. Instrument Shock Environment

The following shock levels apply for METOP. Compliance with these requirements shall be verified by analysis.

METOP Shock Levels (g peak, See notes)		Notes
100 Hz	37 g	The acceleration shall be derived from the curve obtained by linear connection on a logarithmic chart of the provided points
900 Hz	350 g (Q > 10) 310 g (Q = 10)	
2000 Hz	350 g (Q > 10) 310 g (Q = 10)	The shock spectrum in each direction of the three orthogonal axes shall be equivalent to a half sine pulse of 0.5 ms duration and 200 g (zero to peak) amplitude.
4000 Hz	300 g	

Compatibility of ADCS with these requirements is TBC_{ADCS}.

4.1.2. Structural Tests

4.1.2.1. Structural Mathematical Model Validation

Not applicable for A-DCS.

4.1.2.2. Vibration Test : High Level Sine Sweep

The A-DCS does not exhibits any major structural mode below 100 Hz (Cf. § 2.2.8.4.).

The following METOP test level requirements apply :

	High Level Sine Sweep Test Levels (TBC_{MET})
	METOP Requirements
QUAL	All three axes 6 to 20 Hz ±9.3 mm 20 to 60 Hz ±15 g 60 to 100 Hz ±6 g Sweep rate : 2 Oct/min. No notching is allowed
ACC	All three axes 6 to 20 Hz ±7.5 mm 20 to 60 Hz ±12 g 60 to 100 Hz ±4.8 g Sweep rate : 4 Oct/min. No notching is allowed

4.1.2.3. Vibration Test : Sine Burst

Not applicable.

4.1.2.4. Vibration Test : Random Levels

A random test shall be performed with the following METOP levels.

For the definition of the METOP requirements, masses of 15 kg / 7 kg for A-DCS RPU / TXU have been assumed. Final levels will depend on the actual instrument mass and launch environment, and will be scaled accordingly.

Levels are defined in the Table 4.1.2.4-1.

4.1.2.5. Acoustic Test

No test is required at instrument level.

Random Vibration Test Levels (TBC_{MET})					
QUALIFICATION			ACCEPTANCE		
Axis Perpendicular to Mounting Plane			Axis Perpendicular to Mounting Plane		
Frequency Range (Hz)	Power Spectral Density g^2/Hz	Slope (dB/Oct.)	Frequency Range (Hz)	Power Spectral Density g^2/Hz	Slope (dB/Oct.)
20 to 100		+3	20 to 100		+3
100 to 400	0.153 (RPU) 0.236 (TXU		100 to 400	0.098 (RPU) 0.152 (TXU)	
400 to 2000		-3 out-of-plane	400 to 2000		-3 out-of-plane
Overall level : 12.3 g rms normal (RPU) 15.3 g rms normal (TXU) Duration 2 min per axis			Overall level : 9.9 g rms normal (RPU) 12.3 g rms normal (TXU) Duration 1 min per axis		
Horizontal axes 1 & 2 (in the mounting plane)			Horizontal axes 1 & 2 (in the mounting plane)		
Frequency Range (Hz)	Power Spectral Density g^2/Hz	Slope (dB/Oct.)	Frequency Range (Hz)	Power Spectral Density g^2/Hz	Slope (dB/Oct.)
20 to 100		+3	20 to 100		+3
100 to 400	0.153 (RPU) 0.236 (TXU		100 to 400	0.098 (RPU) 0.152 (TXU)	
400 to 2000		-4 in-plane	400 to 2000		-4 in-plane
Overall level : 11.4 g rms normal (RPU) 14.1 g rms normal (TXU) Duration 2 min per axis			Overall level : 9.1 g rms normal (RPU) 11.3 g rms normal (TXU) Duration 1 min per axis		

Table 4.1.2.4-1 : Random Levels For A-DCS

4.2. THERMAL VERIFICATION : THERMAL TESTS

4.2.1. Thermal Balance Test

The A-DCS units will be submitted to a thermal balance test, performed at METOP system level to validate the overall satellite thermal control subsystem.

4.2.2. Thermal Vacuum Tests

During the METOP programme, the instrument will not experience temperatures other than those specified in § 2.3.2.

The thermal cycle vacuum tests at instrument level are required to evaluate and demonstrate the functional performance of each unit under the extreme and nominal modes of operation while in vacuum and at temperatures more extreme than predicted for the orbit conditions.

The instrument qualification thermal vacuum test includes TBD_{ADCS} cycles and the extreme temperature levels are TBD_{ADCS} deg. C (min.) / TBD_{ADCS} deg. C (Max).

The instrument acceptance thermal vacuum test includes TBD_{ADCS} cycles and the extreme temperature levels are TBD_{ADCS} deg. C (min.) / TBD_{ADCS} deg. C (Max).

4.3. EMC VERIFICATION

4.3.1. EMC Performance Requirements

4.3.1.1. Conducted Emission

Conducted emission tests shall be done using a LISN specified and provided by ESA.

The conducted emission on each individual power line shall not exceed the limits as given below.

- Limits for +28 V Main Power Bus

  a) As given in § 3.4.3. (Load Current Ripple)

  b) Conducted emission in the frequency range 30 Hz to 50 MHz, which may appear on positive and return leads in differential and common mode, shall be within the maximum specified levels of Fig. 4.3.1.1-1.

  Note : The maximum frequency of 50 MHz can be reduced to the highest frequency (+9 harmonics) used by the instrument.

  The Common Mode CE requirement is a specific METOP requirement.

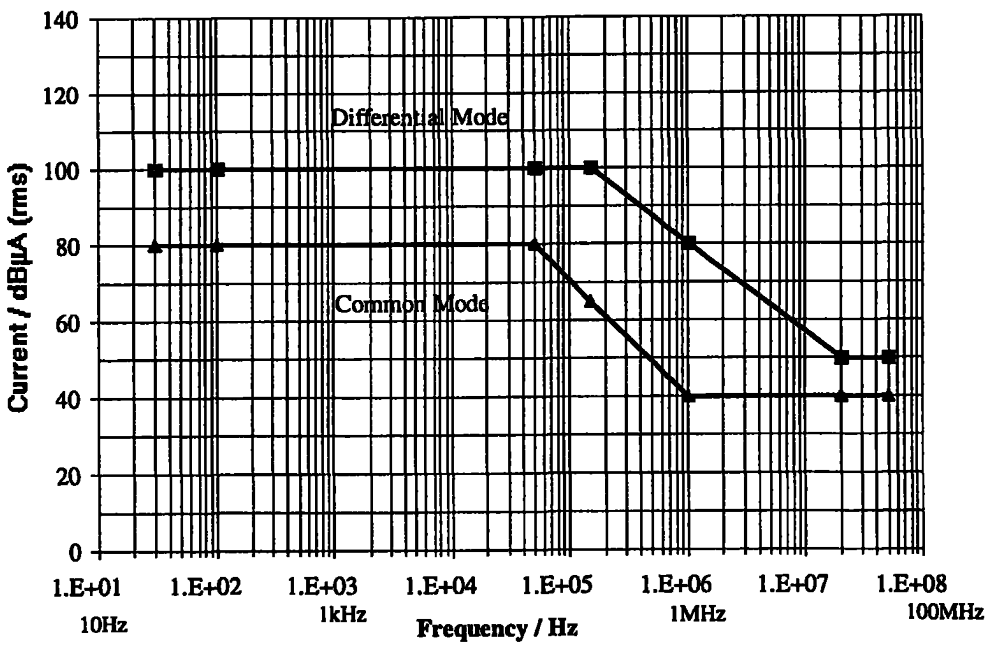


Fig. 4.3.1.1-1 : Conducted Emission Limit NB, 28V Main Power Leads, PLM Instrument

- Limits for +28 V Switched TLM Bus

  As given in § 3.4.3. (Load Current Ripple)

- Limits for +10V Interface Bus

  As given in § 3.4.3. (Load Current Ripple)

4.3.1.2. Conducted Susceptibility

Frequency Domain

The instrument shall operate without degraded performance in the presence of sinusoidal noise coupled into the power lines between the frequency range 30 Hz and 150 kHz :

+28 V Main Bus / +28 V Switched TLM Bus	injected Voltage	300 mVpp
+10 V Interface Bus	injected Voltage	100 mVpp

The test set-up shall be in accordance to § 4.3.3.

Time Domain

The instrument shall operate without degraded performance when subjected to a series of transient pulses, 10 µsec in width and PRF of 10 Hz applied to the power lines for 10 min. :

+28 V Main Bus / +28 V Switched TLM Bus	spike level	+10 V / -12 V
+10 V Interface Bus	spike level	+1 V / -1 V

The test method CS06 shall be in accordance to § 4.3.3.

Special METOP Requirement

The instrument shall operate without degraded performance in the presence of common mode sinusoidal noise 300 mV_{pp} in the frequency range 100 kHz and 50 MHz. The noise shall be injected between :

the +28 V main bus return line and unit housing, according to Figure 4.3.1.2-1

and the +10 V interface bus return line and unit housing, according to Figure 4.3.1.2-2

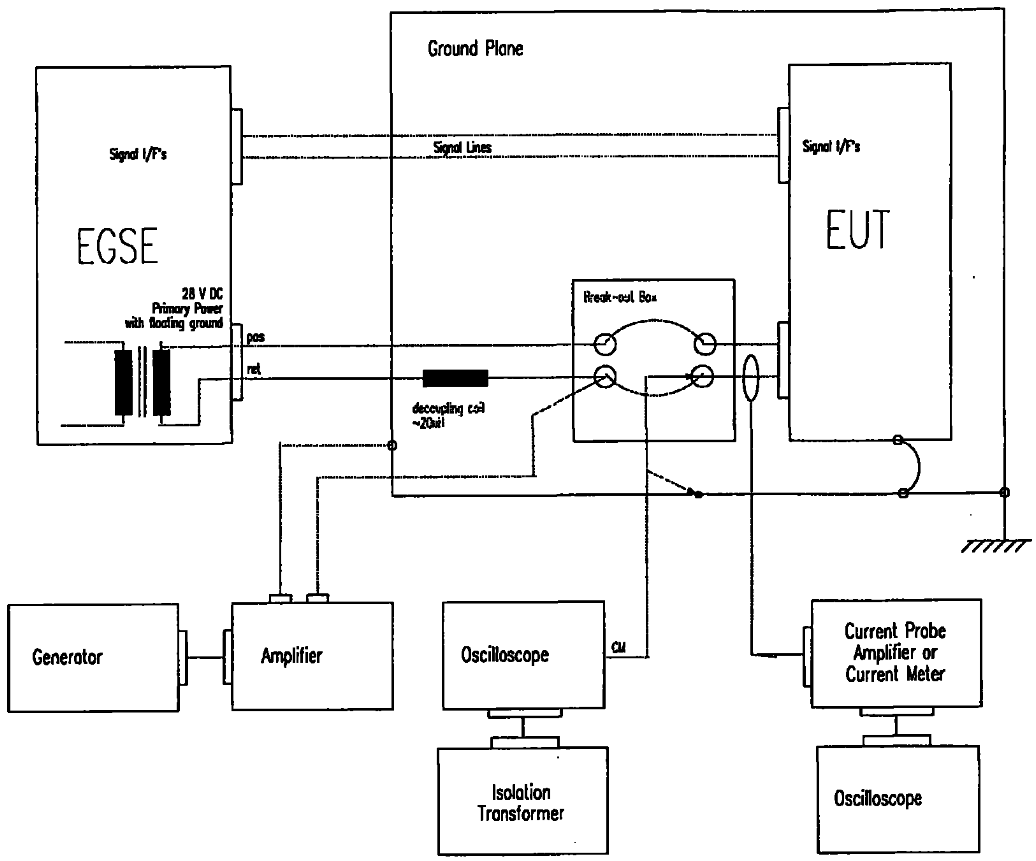


Fig. 4.3.1.2-1 : Common Mode Noise Test on the +28 V Main Bus

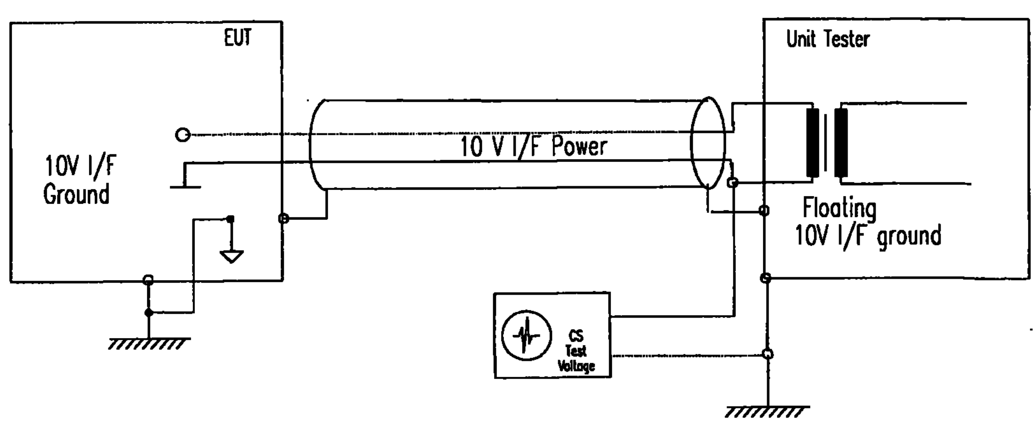


Fig. 4.3.1.2-2 : Common Mode Noise Test on the + 10 V Interface Bus

4.3.1.3. Radiated Emission

Radiated emission in the frequency range 14 kHz to 2 GHz shall not exceed the limit given in Figure 4.3.1.3-1 measured in 1 m distance. In addition the instrument shall not exceed the limits in the specific frequency bands as listed in Table 4.3.1.3-1, measured in 1 m distance. The receiver bandwidth shall be selected in such a way that the ambient noise is below the limit. The test is defined in § 4.3.3.

Frequency Range (MHz)	E-Field Level (dBµV/m)	Remark
120 - 121.45	+ 34	SARR
121.45 - 121.55	+ 15	
121.55 - 123	+ 35	
240 - 242.925	+ 41	SARR
242.925 - 243.075	+ 21	
243.075 - 246	+ 41	
401.8 - 405.9	+ 45	SARP
405.9 - 406.2	+ 23	
406.2 - 411	+ 45	
2051.9 - 2055.0	+ 45	SBS
5254.7 - 5255.3	+ 63	ASCAT
1217 - 1257	+ 21	GRAS
1565 - 1614	+ 23	

Table 4.3.1.3-1 : Radiated Emission Notches for A-DCS

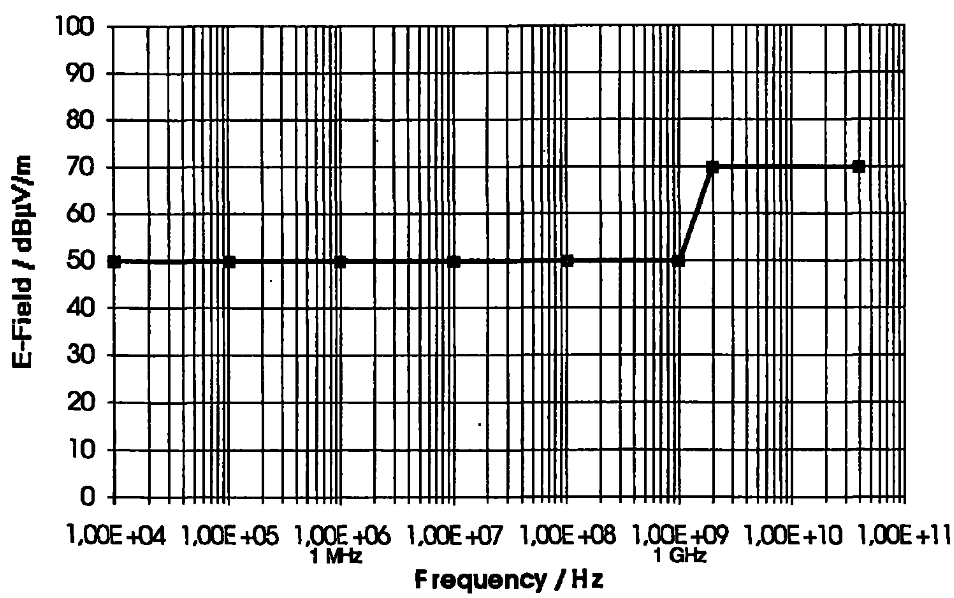


Figure 4.3.1.3-1 : Radiated Emissions, NB, AC Electric Field Limit

4.3.1.4. Radiated Susceptibility

The instrument shall operate without degraded performance while subjected to a radiated electric field of 1 Vrms/m for frequencies between 14 kHz and 1 GHz and 2 Vrms/m for frequency between 1 GHz and 18 GHz. The radiated E-Field shall be amplitude modulated by a sine wave at 1 kHz with a modulation depth of 50 %.

The test method is defined in § 4.3.3.

4.3.2. EMC Analysis

It is the responsibility of the Instrument Supplier to verify the compatibility of the instrument with the EMC requirements, as defined in § 3.8. The verification can be done either by analysis or test, except those items identified in § 4.3.3.

Magnetic Moments

The magnetic moments shall be determined by analysis and confirmed by the incoming inspection.

4.3.3. EMC Tests

The compatibility of the A-DCS with the requirements shall be verified by test for :

- conducted emission
- conducted susceptibility
- radiated emission
- radiated susceptibility

EMC tests shall be performed in accordance with AD4.

The Radiated Emission tests are applicable on all models delivered to METOP.

The Conducted Emission, Conducted Susceptibility and Radiated Susceptibility tests are applicable only on the first instrument model delivered to METOP.

4.4. ELECTRICAL FUNCTIONAL VERIFICATION

The test which are described here are performed at instrument level to validate the instrument functional performances.

Tests performed after delivery, performed under METOP responsibility, are described in § 5.

4.4.1. Electrical Interface Tests

The following test shall be performed prior to delivery to METOP :

- Verification of all interfaces as specified in this ICD.
- Verification of instrument operation, commanding and monitoring with simulated METOP interfaces. This shall be done in all instrument operational modes.

4.4.2. Functional Test

It is the sole responsibility of the Instrument Supplier to define and verify the proper functions of the instrument prior to delivery to METOP. This type of tests are tailored to the specific instrument function verification and they serve as instrument health checks that are performed routinely throughout the instrument development programme. A subset of these tests will constitute later the core of the system testing when the instrument is integrated on-board the PLM.

Test results of these tests shall be provided as reference for further tests performed under METOP responsibility.

4.4.3. Performance Test

It is also the sole responsibility of the Instrument Supplier to define and verify the ultimate mission performances of the instrument prior to delivery to METOP. This type of tests are tailored to the specific instrument performances and they are achieved ultimately with the instrument calibration which requires a rather sophisticated and controlled test set-up.

A subset of these tests may later constitute the system performance test with a reduced on-ground set-up. A go / no-go approach is preferred at system level (PLM and Satellite), due to the complexity of the test set-up and the AIT schedule limitations.

Calibration

It is the sole responsibility of the Instrument Supplier to calibrate the instrument prior to delivery to METOP. Re-calibration, if deemed necessary, will also be under the responsibility of the Instrument Supplier. The calibration data shall be made available on-request for the preparation of the system integrated instrument performance test.

5. INSTRUMENT GSE AND AIV INTERFACES

5.1. INSTRUMENT GSE DESCRIPTION

5.1.1. Bench Test Equipment

The Instrument Supplier will provide all test equipment required for bench test of the instrument. This equipment (Bench Test Equipment - BTE) shall include a Satellite Simulator, a Stimuli Generator (STE), a Receiver Test Equipment (RTE), a Data Processing module and a Computer. Figure 5.1.1-1 provides an overview of the bench test set-up. Shielded enclosure : see § 5.7.1.

The test equipment is a stand alone equipment that simulates the spacecraft interfaces and provides the RF stimuli and outputs. The test equipment used for the A-DCS is also used for SARP-3 (see SARP-3 ICD). Simultaneous operations with A-DCS and SARP-3 are not possible with only one BTE. Details are TBD_{INST}.

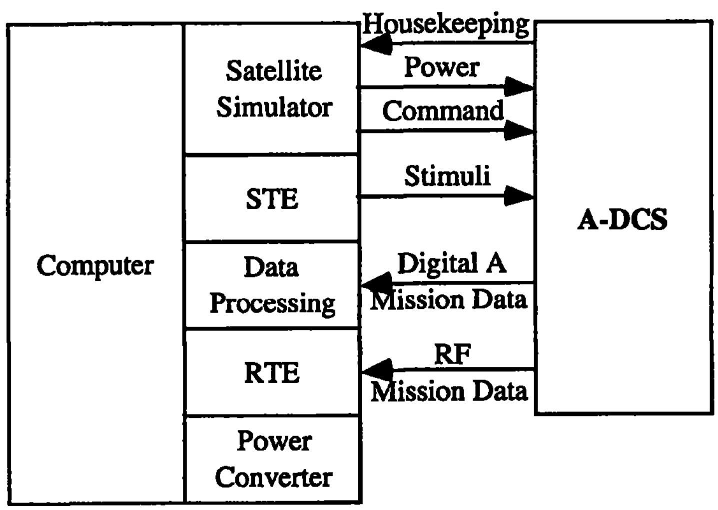


Figure 5.1.1-1 : Overview of the Bench Test Set-Up

The ADCS Bench Test Equipment can be used in an end-to-end test, including the METOP provided antenna. It accepts a RF input from the ADCS transmitter via RF coaxial cables or via intermediate antenna test cap. Details about Bench Test Equipment receptor sensitivity is TBD_{ADCS}.

Standard laboratory equipment such as spectrum analyzer, power meter, counter can be made available by METOP to support bench tests of the instrument : TBD_{INST}

5.1.2. GSE for Integration with PLM OCOE

The test equipment for integration into the PLM overall check-out equipment (OCOE) will be provided by the instrument. One set consists of the following items :

- a platform simulator for generation of test messages to the instrument (= STE)
- a receiver test / demodulator for retrieval of the down linked test messages from the instrument (= RTE)

If needed, the same tests can be performed with the Bench Test Equipment (STE / RTE).

5.1.3. Mechanical Ground Support Equipment

Drill jig : N/A.

Containers shall be supplied for shipping and storage at the METOP integration and test sites for each deliverable instrument.

Anti-static protective covers and connector savers shall be delivered with each instrument for all connectors.

5.1.4. Self-Contained Special Test Equipment

The following special test equipments are delivered by the Instrument Supplier :

1) Digital Analog Converter (DAC), to be used during EMC tests (see § 5.6.1.3.).

2) Dual Channel Dynamic Analyzer (HP35670A), to be used during EMC tests (see § 5.6.1.3.).

Test harnesses between the instrument and the DAC, and between the DAC and the Spectrum Analyzer are provided by METOP.

5.2. INSTRUMENT GSE INTERFACES

5.2.1. Interfaces with PLM OCOE

5.2.1.1. General

The configuration of the A-DCS instrument test equipment within the overall check-out equipment for the METOP payload module is shown in Figure 5.2.1.1-1. The same configuration will be used for TB/TV tests, however with a longer interconnect harness between instrument and stimuli equipment and additional test chamber feed throughs connectors.

5.2.1.2. Stimulus/Feedback Equipment Interface

5.2.1.2.1. Physical / Electrical Interface

The communication between the DAPB controller and the A-DCS Simulator Test Equipment (STE) shall be accomplished via a full duplex three wire serial RS 232 port.

The command and control interface between the A-DCS Receiver Test Equipment (RTE) and the N-DAPB shall be accomplished via a RS 232 asynchronous serial link.

5.2.1.2.2. Protocol Interface

The communication protocol for message handling will be similar to AD9.

5.2.1.2.3. Stimulus/Feedback Data Handling Requirements

Command and control messages between the N-DAPB and the A-DCS Simulator Test Equipment (STE) and the Receiver Test Equipment (RTE) shall be logged by the N-DAPB controller.

5.2.1.3. Interface with Instrument provided Data Processing Equipment

N/A to A-DCS.

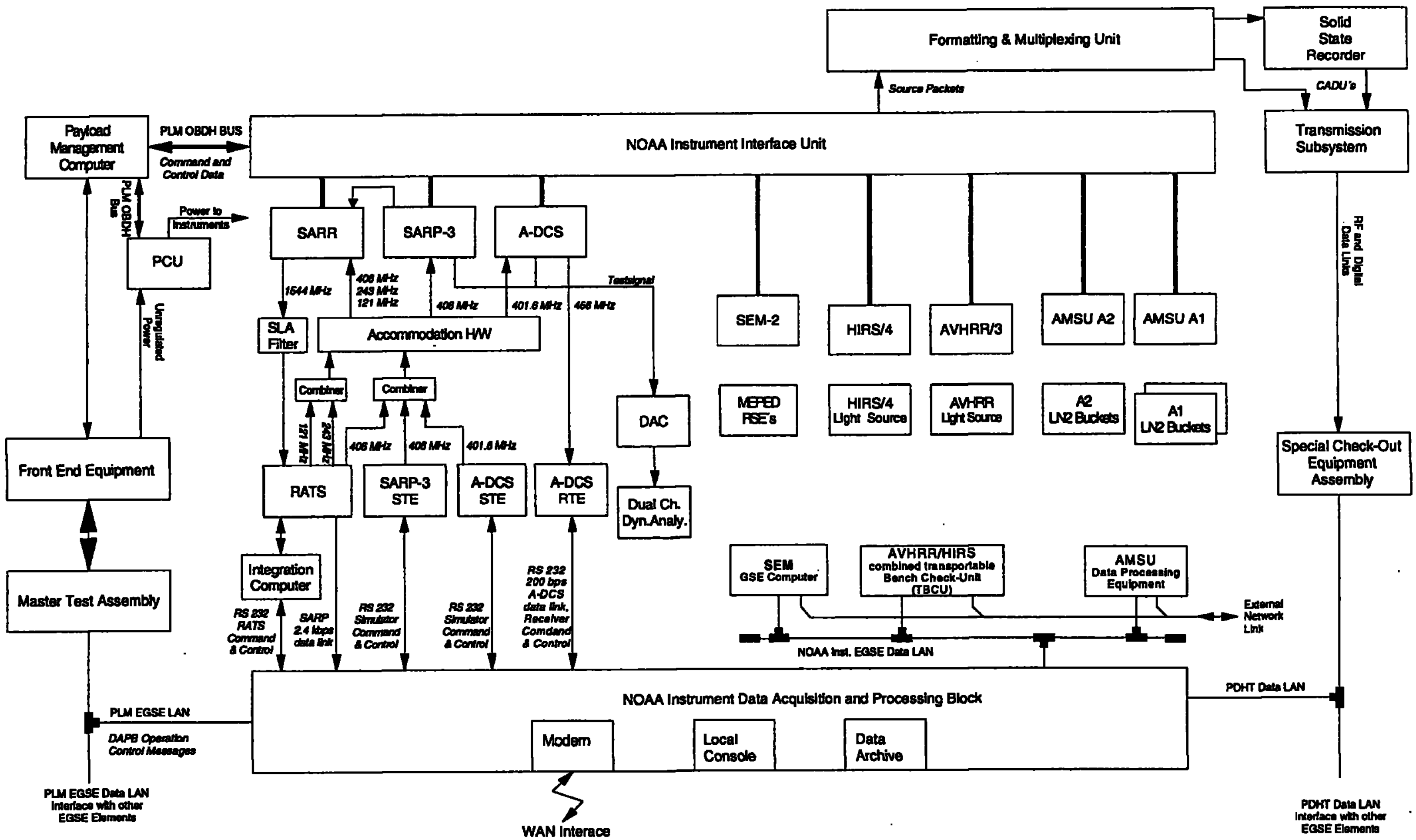
5.2.1.4. Measurement Data Evaluation

5.2.1.4.1. Instrument Measurement Data Format Definition

The A-DCS mission data contain test messages which are generated in the Simulator Test Equipment (STE). The data, as defined in § 3.3, are routed to the N-DAPB via the PLM payload handling and transmission system and the SCOE assembly.

5.2.1.4.2. Data Processing

See AD9.



Note: This drawing shows the Ambient Test Configuration of SEM-2, AVHRR/3, HIRS/4, and AMSU A1/A2. The Thermal Vacuum Test Configuration is different for these instruments.

Fig. 5.2.1.1-1 : Test Equipment Interfaces With PLM OCOE in Ambient Test / Thermal Vacuum Configuration

5.2.2. Interfaces with the PLM On-Board Equipment

5.2.2.1. Test Harness and Connectors

Test connector : see § 3.6.

RF test cables and attenuators (up to 130 dB) shall be provided by METOP at the input / port of the instrument. RF decoupling between simulator and instrument is required.

On PLM / system levels, spacing of > 10 m between the instrument and the check-out equipment is needed.

5.2.2.2. Special Test Adapters (T-Junctions, Break-Out Boxes)

Instrument to PLM avionics interfaces are all via standard sub-D type connectors, therefore no special adapter is needed from the instrument.

Instrument is supplied with connector savers.

5.2.2.3. Stimuli Source Configuration / Arrangement Requirement

N/A

5.2.3. Interfaces with other PLM GSE

N/A

5.2.4. Interfaces with AIT and Launch Site Facilities

5.2.4.1. Mains Power

The instrument test equipment will be operated from mains power via a METOP-provided isolation transformer with the following output characteristics :

- Voltage : 230 V AC (± 10%), 10 A max., single phase
  or 400 V AC (± 10%), 25 A max., three phase
- Frequency : 50 Hz ± 1 Hz

The actual estimated steady state power consumption of the instrument is as follows :

- Bench Equipment : < 2.5 kVA
- Simulator Test Equipment (STE) : < 1 kVA
- Receiver Test Equipment (RTE) : < 1 kVA

5.2.4.2. Cooling / Thermal Dissipation Requirements

N/A

5.2.4.3. Purging Gas Requirements

N/A

5.2.4.4. GN_2 / LN_2 Supply

N/A

5.2.4.5. Test Chamber Wall Feed-Through Panels

For TV test, two coaxial / RF cable feed-throughs for the A-DCS shall be provided by METOP.

5.2.4.6. Public Data Net Communication Requirements

The METOP AIT and launch site facilities will provide access to a public data network in order to enable data exchange with Instrument Suppliers (e.g. for off-line data evaluation at the A-DCS Instrument Supplier premises).

For this purpose, file transfer procedures via INTERNET will be used.

5.2.4.7. Physical Interfaces

(GSE weight, dimensions, floor loading, door width, and others TBD_{INST} by A-DCS)

The bench test equipment (BTE) consists of one full-sized 2 m high, 483 mm (19 in.) wide rack.

For stimuli and feedback equipments, three (3) drawers of 10 u. / 483 mm (19 in.) are needed :

- 2 for the Simulator Test Equipment (STE)
- 1 for the atomic clock.

STE and atomic clock drawers shall be integrated in the METOP provided EGSE racks.

The Receiver Test Equipment (RTE) is a stand-alone box.

For set-up of the instrument test equipment an area of TBD_{INST} m^2 as a minimum shall be provided in a temperature and humidity controlled class 100,000 clean area.

5.3. INSTRUMENT GROUND OPERATION REQUIREMENTS

5.3.1. General

Instrument operational constraints are presented in § 1.4.1. Test procedures may deviate from these.

Instrument modes and in orbit operations are described in § 1.4 and § 1.5.

Instrument telecommands are described in § 3.2.2.

For the ground operations, the acknowledgement of the commands by the instrument is done using Analog Housekeeping and Digital B data from the instrument, as described in § 3.2.3.

Conditions for testing

TBD_{INST}

5.3.2. Command and Control Sequences

The testability of the instrument depends on the usage of equipment as is outlined in Table 5.3.2-1 below. Command and control sequences will be implemented in the check-out software of the METOP overall check-out equipment in terms of control files for automated testing. The control files will ensure that the instrument is operated and tested in accordance with the objectives given below. Control files will be coded on the basis of test procedures prepared by the METOP AIT team following inputs from the Instrument Supplier, and checked by the instrument supplier.

Control files shall take into account the generic operation requirements given above, and the special requirements for ambient and TV testing given in the following subchapters.

TBD_{INST}

Table 5.3.2-1 : Test Objectives Versus Test Configurations

5.3.2.1. Ambient Conditions

No special ambient condition shall be observed. The same sequences as described in § 1.5 apply here.

5.3.2.2. Thermal Vacuum Conditions

No special thermal vacuum condition shall be observed. The same sequences as described in § 1.5 apply here.

5.3.3. Hazards / Precautions

The stimulus equipment shall be operated such that a -15 dBm input level at the instrument is not exceeded.

5.4. INSTRUMENT ACCEPTANCE AT AIT SITE

5.4.1. Unpacking / Packing and Handling Requirements

No specific requirement.

5.4.2. Incoming Inspection

The incoming inspection starts as soon as instrument equipment arrives at the integration site. After unpacking under cleanroom conditions, the following will be carried out :

- Visual Inspection of Instrument and GSE
- Dimensional / flatness check
- Units Weighing
- Bench Testing

Bench Level Tests

Prior to installation and to the PLM and electrical integration with PLM avionics, the instruments shall undergo a bench level check-out to demonstrate aliveness and instrument readiness for the subsequent system level AIT activities.

The instrument will be set up on a test bench (e.g. a table with conductive surface) and shall be connected to the instrument test equipment. In those cases where instruments are accommodated on dedicated panels, they will be mounted directly to the panel. The panel itself is supported by a standard panel handling and turnover trolley. Then a series of check-out activities shall be carried out as required to validate the instrument readiness.

The bench test equipment shall be provided by the Instrument Supplier and shall reside at the PLM and satellite AIV sites to support instrument troubleshooting if necessary. Operation of the instrument and its bench test equipment is done by the Instrument Supplier team with support of the METOP AIV team in accordance to the following instrument-provided procedures and manuals :

TBD_{INST}

5.4.3. Instrument Self-Compatibility Test

Not applicable.

5.5. INTEGRATION ON METOP

5.5.1. Pre-Integration

5.5.1.1. Integration with Accommodation Hardware

TBD_{MET}.

5.5.1.2. Pre-Integration with NIU

Prior to the installation in the PLM, the instrument will be pre-integrated with the NIU and parts of the NIU test equipment as well as the power conditioning unit. The corresponding set-up of on-board units and ground support equipment is shown in Figure 5.5.1-1.

The purposes of the pre-integration activities is to verify electrical interfaces between instruments and NIU and PCU, to develop instrument specific test sequences, and to refine and validate the DAPB operation separately from the PLM level AIT in order to reduce the overall integration time.

The activities carried out with the instruments in the NIU pre-integration are electrical integration and instrument IST's as described in § 5.5.3 below.

The physical arrangement of the instruments during pre-integration will be on desks with conductive surface. The interconnection to the NIU and PCU is accomplished with a METOP-provided test cable harness. Pre-integration activities are done in a clean room environment as required.

After completion of the pre-integration activities the instruments together with the NIU and the PCU will be installed in the payload module. An abbreviated electrical integration and part of the IST's are then repeated.

5.5.2. Mechanical / Thermal Integration

The instrument mechanical / thermal integration includes the following activities :

- Physical installation to associated PLM panels according to agreed procedures including thermal insulation / filling and other
- Mechanical adjustment as required
- Installation of thermal fillers / insulators as required
- Mounting of thermal blankets
- Bonding measurement between equipment case and PLM structure
- Mechanical integration of pre-integrated instrument panels to the payload carrier structure

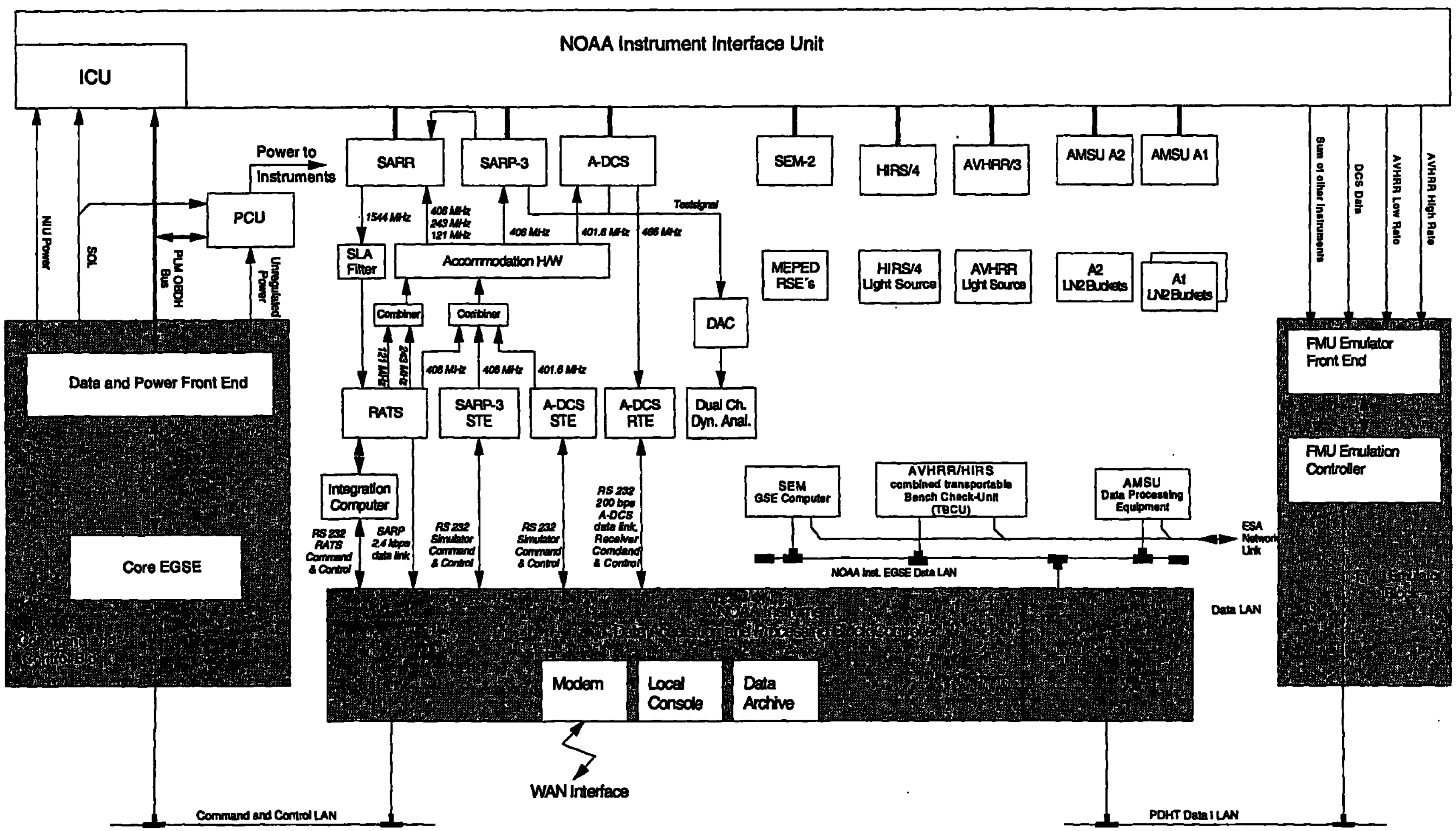


Figure 5.5.1-1 : Set-Up for Instrument Pre-Integration

5.5.3. Electrical Integration and IST's

The electrical integration of the instrument is done after the integration of its GSE. The purpose of the electrical integration of the instrument on-board equipment is twofold : to verify that the interfaces between the instrument and the PLM avionics are as specified, and to accomplish instrument operation commissioning within the PLM environment.

The following activities are carried out for electrical interface verification :

Instrument Grounding/Isolation Check : before mating any connector with the system harness it is verified, that designated grounding pins are properly terminated to chassis, and other connector pins are isolated. See § 3.8.2. Grounding and Isolation, for measurement validity and flight model safety.

Safety Check : it is verified before connecting the system harness, that there is no unexpected dangerous voltage, nor a short to chassis ground

T-Junction Tests : instrument connectors are mated with the PLM harness one by one via T-junctions, which allow measuring signal characteristics. Power connectors are mated first, followed by command interface connectors and telemetry interface connectors. The instrument is operated from the PLM Command & Control Block (CCB) by sending commands manually. Essential signal parameters such as rise/fall times, signal levels, signal timing, inrush currents and power consumption are recorded and compared against expected (specification) values.

The instrument electrical integration procedures will be prepared by the PLM AIT team on the basis of inputs from the Instrument Supplier, and reviewed and supported by the Instrument Supplier.

Verification of the instrument interfaces will be followed by an instrument IST. The purpose of this test is to perform a reference instrument check-out in the overall system environment.

The instrument will be operated in all relevant modes including degraded modes and redundancy activation. Full instrument operability validation is achieved in the IST. This comprises both the on-board equipment and the ground support equipment and check-out software. It is to be noted that the check-out software, at least the AIT data base with the TM/TC parameter definitions will be re-used during mission operation. Instrument specific control files will be refined and validated in the IST.

In addition to the above objectives, the IST serves to produce reference data sets for the subsequent environmental and system function test programs.

5.5.4. Integration of GSE

5.5.4.1. Integration of GSE with the Flight Equipment

Procedures : TBD_{INST}

5.5.4.2. GSE Integration with PLM OCOE

The EGSE integration is done prior to the integration of the on-board equipment. During this activity, the instrument-provided test equipment shall be connected with the METOP provided PLM EGSE. Generally, EGSE integration basically consists of an end-to-end communication check to demonstrate full operability under control of the Command and Control Block (CCB).

The instrument GSE integration procedures will be prepared by the PLM AIT team on the basis of inputs from the Instrument Supplier, and reviewed and supported by the Instrument Supplier.

5.6. INSTRUMENT OPERATION CONSTRAINTS DURING PLM AND SATELLITE SYSTEM TESTS

5.6.1. System Environmental Test Levels

5.6.1.1. Structural Tests

No specific condition shall be observed in addition to those described in § 2.

5.6.1.2. Thermal Tests

No specific condition shall be observed in addition to those described in § 2.

5.6.1.3. EMC/RFC Tests

Static magnetic fields in excess of 2 Gauss will degrade the ultra stable oscillator performance. No damage will occur to the instrument.

See also § 5.3.3.

For testing at Accommodation Hardware level and PLM / Satellite level, the instrument test connector SHD J223 shall be connected to outside EGSE equipments (DAC and Dual Channel Dynamic Analyzer) via a low attenuation test cable (Radiall, type SHF 5). To meet the PLM / Satellite AIT constraints for EMC tests, an overall cable length of 32 m is implemented at PLM / Satellite level between the instrument test connector and the DAC.

5.6.2. Function and Performance Tests

The following descriptions shall provide a better understanding of the system level tests and are to be understood as for information only.

5.6.2.1. System Functional Tests (SFT)

The system functional test will verify the overall system performance and operability in a series of mission relevant modes. Back up modes, degraded modes and mode transitions will be included. The SFT procedures will be composed of control files which have been validated during IST´s.

5.6.2.2. Special Performance Test (SPT)

SPT´s serve to execute specific performance verifications in the overall system configuration for all those parameters which have contributions from more than one subsystem or for test cases which require a special set-up and operation condition. A typical example is a bit error performance test which involves elements of data acquisition, formatting and transmission.

For the instrument, it is assumed that full performance has been demonstrated as part of the instrument acceptance test program. However, at system level, statistics of processed messages with full (A/B) and crossed (if necessary) redundancies, or a subset of this, will be performed as SPT.

5.6.2.3. Abbreviated Functional Tests (AFT)

The abbreviated function test is composed of a subset of control files and procedures from the system functional test. Its purpose is to demonstrate system integrity after major set-up changes and after transport. No measurement data evaluation will be included in the AFT's but only a verification that the measurement data streams are present. Therefore, no instrument stimulus generation and feedback data acquisition will be done.

Note : The feasibility of such test depends on the access to the interface when the satellite is fully integrated. Alternative SFT methods are TBD_{INST}

5.7. INSTRUMENT CONSTRAINTS ON GROUND ENVIRONMENTAL CONDITIONS

5.7.1. AIT Site

Bench testing with the instrument shall be done in a shielded enclosure (provided as GSE by the Instrument Supplier, need is TBC_{ADCS}) to prevent interference from electromagnetic ambient. Such a requirement is not applicable for tests at METOP level.

Test connector : see § 3.6.

Connector dust caps shall be installed when the instrument is not in use.

ADCS transmitter must never be turned-on without either an antenna, a dummy load or test equipment connected to their output.

5.7.2. Launch Site

TBD_{INST}

5.7.3. Transportation

To avoid damage to the instrument, it shall be transported in its container when not yet integrated to the spacecraft. For transport monitoring shock recorders shall be used.

5.7.4. Storage

For instrument storage the delivered containers shall be used. Purging is not required.

The storage temperature extremes shall be as per § 2.3.2.1.

The humidity limits shall not exceed 60 percent when the instrument is in the shipping container. If this limit is exceeded, dryer agents shall be used. When the shipping container is open, the humidity limit shall be less than 60 percent. Under no condition shall the humidity be allowed to approach the dew point.

Other maintenance, as for example re-calibration, is not planned during storage.

5.8. LAUNCH CAMPAIGN

5.8.1. Launch Preparation

Check-Out on the Launch Range

Instrument launch operations before encapsulation of the satellite into the launcher fairing will be a series of functional tests as already done during the AIT phase. After encapsulation of the satellite, there will be only limited command and control access via umbilical to the service module and the payload module avionics. Therefore, instruments will generally not be operated after spacecraft encapsulation.

5.8.2. Red Tagged Items

N/A

5.9. CLEANLINESS / CONTAMINATION CONSTRAINTS

5.9.1. Instrument Aperture Protection

N/A for A-DCS.

5.9.2. Purging

No purging is required for the A-DCS during METOP satellite or PLM level AIT activities.

5.9.3. Contamination Witness Plate

Not applicable : the A-DCS is not sensitive to contamination.

5.9.4. Decontamination Features / Heaters

N/A to A-DCS.

5.9.5. Instrument Bagging

Bagging is required for long-term storage and / or shipping, and when authorized humidity limit is exceeded (see § 5.7.4.).

6. PRODUCT ASSURANCE

The PA approach for the A-DCS is dealt within AD1.

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temperature sensing thermocouples; the ATNAGE provides for the input and controlled conversion of these signals to copper-copper wire pairs prior to monitoring or measurement device inputs.

Twenty thermocouple-monitoring inputs will be allocated for general spacecraft temperature monitoring; the 40 remaining environmental sensor inputs are available for instrument STE temperature or status monitoring.

5.4.5 DCS/SARP Special Test Equipment (DCS/SARP STE)

5.4.5.1 DCS-2/SARP-2 Special Test Equipment (NOAA-N)

The DCS-2/SARP-2 STE provides test messages to the DCS-2 and SARP-2 equipment on the spacecraft under manual or ATNAGE control. This equipment is GFE.

5.4.5.2 ADCS/SARP-3 Special Test Equipment (NOAA-N')

The ADCS/SARP-3 STE provides test messages to the ADCS and SARP-3 equipment on the spacecraft under manual or ATNAGE control. This equipment is GFE.

5.4.6 SARR Special Test Equipment (SARR STE)

The SARR is GFE and is capable of operating in a local mode or under the control of the ATNAGE. The testing of the SARR is under control of software in the SARR STE; the ATNAGE acts as a scheduler.

5.5 FRAME SYNCHRONIZERS

The frame synchronizers provide serial PCM baseband data for input to the ATNAGE computers. The Rarick Consulting Inc. Advanced TIROS Frame Synchronizer, TFS100 unit, is intended for use in preprocessing Advanced TIROS N S/C serial telemetry data streams. The TFS100 will generate frame synchronization pulses, word synchronization pulses, serial data, and bit clock outputs for the following data types:

Type	Rate (bps)
a. TIP	8320 or 16640
b. AIP	16640
c. SARP	2400
d. GAC(1)	66540
e. HRPT	665400
f. TR PB	2661600 or 332800
	(LAC(1)(2), GAC(1)(2), TIP, AIP< BER (1)

(1) Automatically de-randomized
(2) Both forward and reverse patterns

The TFS100 can be used to synchronize and preprocess any of the above data streams as well as any other generalized serial data stream up to a rate of 5.0 megahertz. The TIROS data stream parameters are already preprogrammed in this unit, and can be selected by simply selecting the data type. Ten additional frame parameters may be entered and stored by front panel key pad. The maximum limits of the TFS100 are:

a. Frame Size (up to 1,048,576 bits)

b. Sync Pattern Size (up to 64 bits)

c. Sync Pattern Mask (same number of bits as sync pattern)

d. Synchronization Pulse Bit offset (up to +/- 2 bits relative to start of frame)

e. Telemetry Word Size (up to 32 bits)

f. Error Counts (15 bits -- 32767 max) ## (BER and PB Aux Sync only)

g. Number of "Check" Frames (0 to 15)

h. Number of "Flywheel" Frames (0 to 15)

The TFS100 also includes a static frame simulator for all standard TIROS data streams which can be used for self-testing. A special "data decommutation" feature is also included which allows decommutation and display of a selectable data field conditioned on the contents of another data field.

5.5.1 RCI TFS100 Hi Rate Frame Synchronization

The TFS100 frame synchronizers operate as described in Paragraph 5.4.2.3.2. They provide the following standard functions:

- Accept TTL NRZ-L serial data as well as 0- and 90-degree clock signals from bit synchronizers.
- Detect and frame synchronize to following selectable formats and rates:
  - GAC (2.6616 or 1.3308 Mbps) in forward or reverse format
  - LAC (2.6616 or 1.3308 Mbps) in forward or reverse format
  - HRPT (0.6654 Mbps) in forward format
- Provide either 10-bit or 16-bit parallel TTL NRZ-L word output, plus word and frame clocks.
- Count bit errors in last 1,000 bits of each frame, and provide this information as a four-bit output.
- Provide status outputs.

5.5.2 RCI TFS100 Low Rate Frame Synchronization

The TFS100 frame synchronizers provide the following functions:

- Accept TTL NRZ-L serial data as well as 0- and 90-degree clock signals from bit synchronizers.
- Detect and frame synchronize to the following selectable formats and rates:
  - Realtime TIP (8.32 or 16.64 kbps) in forward format.
  - Playback TIP (0.3327 Mbps) in forward or reverse format.
  - Playback AIP (0.3327 Mbps) in reverse format.

- Provide synchronized 16-bit parallel TTL NRZ-L word outputs plus I/O controls to the Data General computer interface
- Provide status outputs
- Accept front panel or computer control inputs.

Programming of each unit requires three sequential 8-bit RS-232 words. Each word contains an 8-bit addressing code and an 8-bit instruction code. Items to be programmed include Unit address, frame sync polarity and frame sync pattern.

5.6 ATNAGE SYSTEM

5.6.1 Overview

The ATNAGE is an Aerospace Ground Equipment (AGE) test system designed to support testing of the ATN-N, N' spacecraft during integration and pre-launch activities.

During such a test, the ATNAGE system sends commands to the spacecraft and monitors the status of the on-board hardware and software systems by processing the telemetry and the high-rate data streams, and displaying, printing and/or strip-charting the results in realtime. In addition, some raw as well as processed data is stored in the on-line disk storage and/or tapes for subsequent non-realtime analysis.

An automated test procedure controls the system with minimal operator supervision. CRT/keyboard consoles provide operator interaction with the system, and allow manual intervention in the test procedure.

A simulator, which is an integral part of ATNAGE, enables the testing of the telemetry and command functions of the ATNAGE in the absence of a spacecraft.

The SAGE hardware system configuration, shown in Figure 5.6.1-1a consists of:

(a) Two Data General corporation MV9600C multiprocessing computers (referred to as A and B each with its own dedicated set of peripherals. Communication between computers A and B is accomplished via Multi-Processor Communication Adapter (MCA) units. Each computer is capable of running multiple processes simultaneously.

(b) LMSS customized data processing hardware

(c) LMSS customized and government furnished special test equipment and interfaces

The ATNAGE computer support systems shown in Figure 5.6.1-1b consist of:

(a) RCI ATN Spacecraft Simulator–Consisting of one PC multiprocessing computer with supporting disk storage systems, CRT keyboard terminals and printer. Six RF downlink transmitters with pre-modulator filters and RF transmitters with final stage modulators are included. Additionally command up link processing is provided by an RF command receiver, phase demodulator, PSK demodulator and command decrypter. This complement of equipment is required to support SAGE readiness verification.

(b) Off-line computer–Consisting of one Data General Corporation MV9600C multiprocessing computer with supporting disk storage system. Magnetic tape drivers, CRT keyboard terminal, and line printers. An IBM PC is provided with graphics and TIROS SAS network capability.

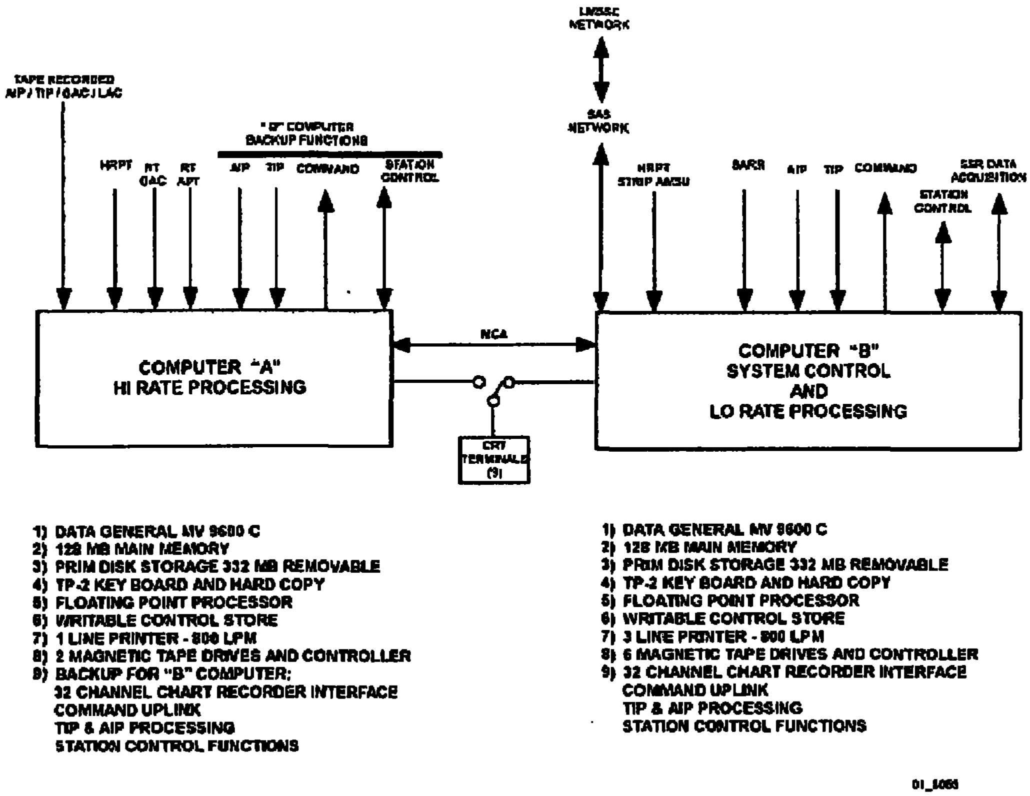

Figure 5.6.1-1a. SAGE Hardware System Configuration

The ATNAGE software is designed to operate under the Advanced Operating System (AOS/VS) which supports a multi-processing environment. The software provides for interprocess, and interprocessor communication; supports shared memory and supports high-level languages such as FORTRAN 7, C and APPLE. The ATNAGE software consists of five subsystems and their corresponding support software. The nominal configuration of these subsystems is as follows:

a. The BUS Subsystem in Computer B
b. The HRI Subsystem in Computer A foreground (realtime) and Computer A background (non-realtime)
c. The LRI Subsystem in Computer B
d. The Atlas Subsystem in Computer B
e. The ATSIM Subsystem is a PC-based Simulator Computer

The Statistical Analysis System (SAS) Network

A separate computer is available for ATNAGE off-line software processing and other support functions.

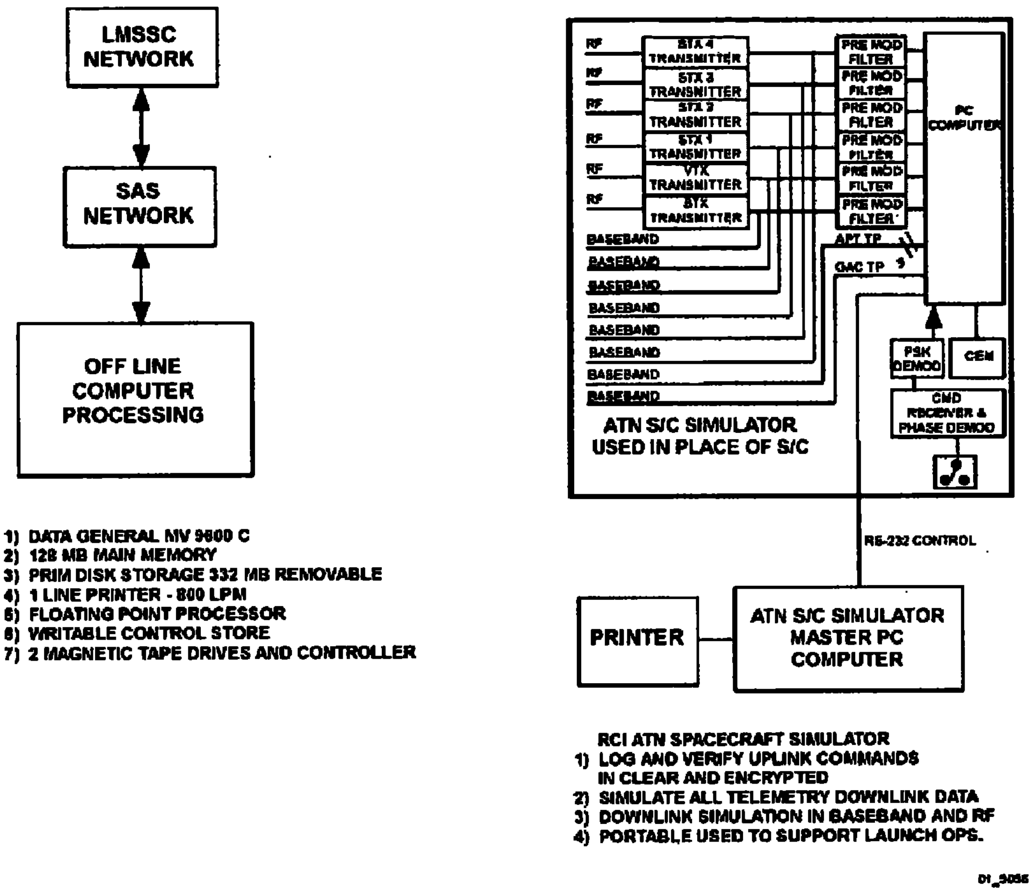

Figure 5.6.1-1b. ATNAGE Computer Support Hardware System Configuration

While it is possible to operate ATNAGE in a "reduced" configuration, by not enabling some of the above subsystems, the BUS Subsystem must be active at all times to provide minimal ground support.

The BUS and ATLAS Subsystems are capable of autonomous operation in either Computer A or B. Moreover, the BUS Subsystem can reside in the SDC Computer in the non-realtime (NRT) mode. In this mode, telemetry data is input through a BUS history tape, and the spacecraft commanding and ATLAS functions are not available.

This overview is concerned solely with the nominal configuration.

The major ATNAGE interfaces with the spacecraft, the ground test equipment and the user are through the BUS Subsystem which acts as an executive to the rest of the system. Realtime operator keyboard inputs are decoded by the BUS and forwarded to the destination subsystem (LRI, HRI or ATLAS) over the MCA lines or interprocess messages. Event